NATIONAL PETROLEUM NEWS

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DETROIT

Coast Guard Cutter Clears Path Through Ice for Oil Barge

A loaded barge of fuel oil moves slowly in the path of the Coast Guard's ice-breaker "Ojibwa" on Boston's Charles River with the temperature hovering near the zero mark. This scene illustrates one of the difficulties encountered in the last few weeks in keeping the eastern section of the country supplied with vital fuel oil in the face of subzero temperatures, and heavy snows which brought on a serious transportation emergency. **(See page 3 for details)**

Press Association Photo

Tips for Transportation Engineers: Emil P. Gohn, automotive engineer of Atlantic Refining, tells S.A.E. meeting of experiments with immersion heaters to reduce engine starting time. Details on Page 26.

Hardest Year Since Start of the War for Automotive Users: Combined report of ODT, WPB, PAW and OPA released by OWI, cites shortage of lead for batteries as greatest threat to transport; urges more share-the-ride pools. Complete details start on Page 14.

203F

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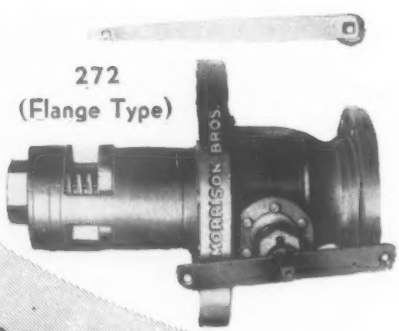

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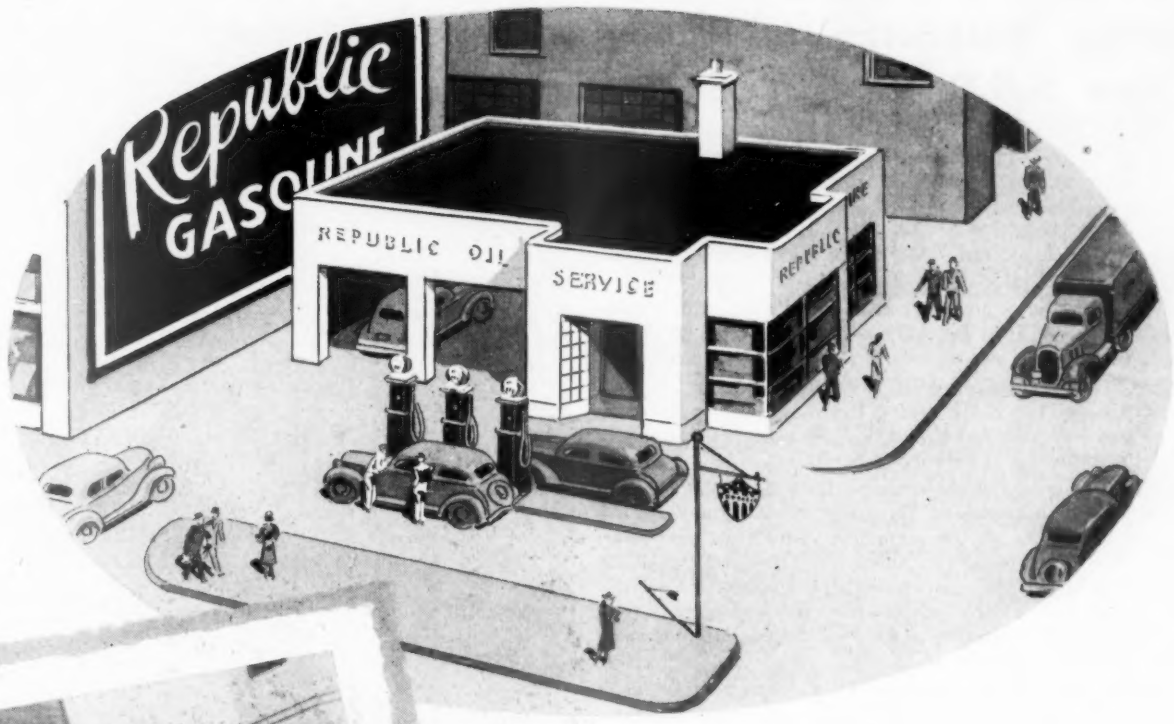


IT'S MAKING CUSTOMERS *that counts*

"Building sales volume is the basis of the retail gas business, but it's making customers that insures real success," according to Art Sperandeo, Republic dealer in Sewickley, Pa.

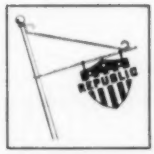
Art has been operating his Republic station since 1934. He began very modestly but through smart merchandising, quality products, and personal attention to each customer, his station, at Beaver and Chestnut Streets, is now one of the most popular in town.

Republic's post-war plans call for tremendous expansion. Our dealers and jobbers will benefit. Hop aboard the Republic band wagon and inquire how you can profit by working with us, because . . . .

REPUBLIC'S GOING PLACES

REPUBLIC OIL COMPANY

Benedum Trees Building



Pittsburgh, Pennsylvania

Postwar Tinkering Is Hobby of New S.A.E. Vice President

EMIL P. COHN, Philadelphia, automotive engineer of the automotive transportation department of Atlantic Refining Co., is the new vice president, representing transportation and maintenance activity, of the Society of Automotive Engineers. Gavin W. Laurie of Atlantic held the post in 1940.

Educated as a Mechanical Engineer, Mr. Gohn took a B.S. degree at the University of Pennsylvania and joined Atlantic's research and development department. In 1936 he transferred to the Automotive Transportation Department.

He has been a member of the transportation and maintenance activity of the S.A.E. since 1941, and was appointed vice-chairman of the S.A.E.-O.D.T. Maintenance Methods Activity Committee in 1943. (*See p.* 26)

In 1941-42 he served as chairman of the Philadelphia section of the S.A.E. In addition to his many other activities, Mr. Gohn was a member of the committee which gathered the data for the ODT booklet, "America's Trucks—Keep 'Em Rolling," as well as being a member of the committee which studied "Tubeless Tires", under the sponsorship of the P.I.W.C. He is also a member of the Philadelphia Maintenance Advisory Committee for the ODT.

Mr. Gohn's main hobby is work. Often after putting in a full day on the job he hurries out to the truck maintenance plant and tinkers around with electronics and other postwar ideas. His friends say he is a better pianist than a golf player, and recall that he worked his way through college "tickling the ivories".

His election to his present office with the engineering society took place at the S.A.E. annual meeting in Detroit.

Emil P. Gohn

NPN Mails 25th Issue of Its Overseas Edition; Copies Go to Oil Men All Over the World

NPN has just completed mailing the 25th issue of its overseas edition to oil men in the fighting forces all over the world and we deem this an appropriate time to let our readers know something about what we have been trying to do.

The first issue was printed on Aug. 16, 1944, and the idea was suggested by Warren C. Platt who on his arrival in Europe found a great thirst by oil men for news of what was going on in the industry back home.

Mailing privileges being limited, it was necessary to keep down the size and this was solved by a careful selection of what NPN's editors thought oil men in the service would be most interested in reading. Therefore, only the most important articles, including Mr. Platt's reports, are printed in full. There is generally a page of personal items and the rest of the news is condensed, although anything with a postwar slant is given preference. It has been found that oil men are greatly interested in what is likely to happen in peacetime despite present pre-occupation with the war.

Some other facts:

Total circulation of the overseas edition is approximately 4000.

Thirty-seven oil companies in the U. S. receive about 3500 of these copies for distribution among their men in the services.

NPN, itself, sends about 500 copies airmail to American and British service men, to foreign representatives of American firms, and to British oil companies. Some copies go direct to Egypt, India, Iran, Palestine, Syria, Algeria, Morocco, Italy and the Persian Gulf. Other copies go to the Pacific area.

We have been told that the edition is popular, that copies are passed around and read eagerly, so that actually the edition reaches many more men than the 4000 copies would indicate.

That's about the story; except that we are constantly trying to improve the reprint. It has been a source of considerable pleasure and satisfaction to NPN's editors.

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NATIONAL PETROLEUM NEWS
NPN
NEWSMAGAZINE FOR OIL MANAGEMENT MEN

East Coast Oil Crisis Averted as Freight Lines Are Untangled; Gas Better, Too

Situation Is Still "Touch and Go," PAW Repeats, but Maintains Fuel Oil Ration; Tank Cars in Good Run

NPN News Bureau

WASHINGTON—The jam of rail freight, caused by the severest weather in years, began breaking up this week, to brighten somewhat the prospect of the East working its way out of an oil supply crisis that even yet could become the worst of the war.

That the situation is still "touch-and-go," with many an "if" in the picture, was frankly conceded by PAW.

Minimum essential needs of civilian consumers can continue to be met, said PAW, "unless too many crippling things happen at once." Then it added this summation of prospects for the weeks ahead:

"We are sparing no effort, and if the public continues to cooperate by keeping its consumption of fuel oils and gasoline at the lowest possible minimum, and if further storms or lower temperatures or even worse ice conditions do not cripple us, we will be able to keep the East Coast situation in line without calling on consumers for greater sacrifices than they have been making."

Coupon Value Maintained

Backing up the PAW belief that the situation can be "kept in line," was the action of OPA in maintaining fuel oil coupon values for period 4 in the East at 10 gallons, effective Feb. 5. OPA, however, warned of the tight situation and said that householders would have to cut down on their use of rations still further during the next two months "if temporary local shortages are to be avoided." (*See p.* 55)

On the storm-beleaguered transportation front, the week found rail officials displaying their first signs of optimism in nearly two months.

As a result of two successive week-end embargoes on civilian freight loadings—only the first of which applied to oil shipments—a good run of cars began arriving at seaboard delivery points, and prospects were that shipments would build up steadily over the next several weeks provided the weather behaves. Even so, however, loadings last week probably averaged no more than 425,000 b/d, due to fact that many cars had not yet been able to get back to shipping points.

Gas Supplies Improve

The situation with respect to natural gas supply also appeared to have brightened, largely as a result of a week-end ban on use of the fuel by places of amusement in the District of Columbia and the seven states of New York, Pennsylvania, Maryland, Virginia, West Virginia, Kentucky and Ohio.

"The immediate crisis threatening collapse of natural gas pressures in the Appalachian areas has been weathered successfully," said Office of War Utilities Director Edward Falck.

He warned, however, that the severe cold has left reserves and supply line pressures seriously reduced, and said that "continued conservation by everyone using gas is still essential" for the reason that "any recurrence of unusually cold weather will bring another dangerous situation."

Brownout Darkens Station Pump Globes Advertising Brands

NPN News Bureau

WASHINGTON — WPB's new question-and-answer bulletin No. 2 on brownout regulation U-9, includes a warning to service station operators and others that it is not permissible to light the globes on gasoline pumps identifying the brand of gasoline sold. (*Another brownout story, p.* 9).

Answering its question as to whether such lighting is permissible, WPB says: "No. Unless the light bulb which illuminates the upper globe is used also to illuminate the dial, or is the only general illumination necessary for the carrying on of business, such lighting is not permissible."

The bulletin also gives a negative answer to the question: "May business associations or other business groups make group appeals for relief from the restrictions of Utilities Order U-9?" All appeals under paragraph (e) of the order must be made on an individual case basis, and no group or class appeals will be entertained, WPB said.

Ten Dead and Hundred Injured In N. Y. Tanker Disaster

NEW YORK—At least 10 persons are known to be dead, about 23 are missing and more than 100 are reported injured in an explosion following the collision of two tankers, the "Springhill," 17,000-ton War Shipping Administration vessel operated by Barber Asphalt Corp. and an 8000-ton Pan American tanker "Pan-Clio" in upper New York Bay, Feb. 5. (*For a report on another tanker disaster see p.* 13).

Coast Guard advices said the "Springhill," with a crew of ninety men, was riding at anchor between Stapleton, Staten Island and Bay Ridge when she was rammed by the "Vivi," a 10,000-ton Norwegian vessel, which had just weighed anchor and was moving northward. The "Pan-Clio" also northbound, struck the "Springhill" about 20 feet from the port bows.

Oil Policy Committee Wants Hand in Pact

NPN News Bureau

WASHINGTON—A move by the Senate National Oil Policy Committee to take an active part in revision of the Anglo-American Oil Treaty, in the hope of obtaining a document which will meet with unanimous approval of executive and legislative branches as well as the oil industry, can be looked for in the near future, NPN learned this week.

Aim of the committee, according to one member, will be to try to unite U. S. opinion behind a single document in advance of renegotiation with the British, thereby eliminating the possibility of later controversy.

The committee, existence of which has been continued for the life of the 79th Congress by vote of the Senate, plans on holding an early reorganization meeting but no date had been set at NPN presstime.

First business will be that of electing a successor to the late Sen. Maloney, of Connecticut, as chairman. There are two contenders for the post—Sen. O'Mahoney, of Wyoming, who reportedly wants the job, and Sen. Johnson, of Colorado, who has the backing of some of his colleagues and is believed to be receptive to the idea.

Meeting for the first time with the group, when it convenes, will be Sen. Overton, of Louisiana, who was appointed this week to be one of the Senate Commerce Committee's two representatives on the Oil Policy committee. He fills the vacancy created by the death of Sen. Maloney.

Not only does Sen. Overton come from an oil state, but he also is author of the so-called Overton resolution which would implement the Federal Power Commission in its current investigation of the nation's natural gas resources.

Refiners' Advisors Delay Meeting Until March

NPN News Bureau

WASHINGTON — First meeting here of OPA's recently-established National Refiners Industry Advisory Committee will be held March 15 instead of Feb. 20, OPA said this week.

The meeting has been postponed until that time so that it will coincide with the next P.I.W.C. gathering, which is scheduled for March 14.

Shivering Military Technicians in Europe Call for Help; Seek Ideas on Improvised Oil Stoves That Will Give Heat

In the accompanying article, though written in a light vein, Mr. Platt calls attention to the plight of many military people in liberated countries who have to work in cold billets and offices.

Apparently some petroleum products are available for heating but these people lack, of course, modern type oil burners and space heaters. They have improvised various instruments to burn the oil to give heat but apparently with little success.

Read this article. Maybe you can make a suggestion that will be just the thing these technicians have been looking for to make these hurriedly contrived contraptions really work. Mr. Platt's idea is that perhaps something can be worked out for the next war. But maybe, if we hurry, something can be done to relieve these shivering gentlemen in this one. Send your suggestions to

Editor of the NPN Mission to France for Relief of Shivering and Helpless Scientific Oil Men,
1213 W. 3rd St.,
Cleveland 13, Ohio

By Warren C. Platt

FROM ANYWHERE IN COLD FRANCE, ITALY OR ENGLAND — What all these highly technically trained oil men who are over here shivering in unheated offices and billets while fighting the war for democracy need, above all things, are a couple of birds who really know how to improvise an oil heating device out of little or nothing and make the darn thing heat up a place.

Much skilled thinking, devising, planning, advising and consulting, even blowing on the struggling but always meager flame, has occurred but billets are still chilly to cold and offices remain at shivering temperature. Ph. D.'s, men with degrees of from M.S. and B.S. in chemical engineering, mechanical engineering, as well as production engineers, refinery experts and gentlemen in the nautical garb of the Navy, have struggled with the problem.

They have caused to come forth from various garage repair shops, from pipeline shops in tents, from captured but generally blown up refineries, all sorts of contraptions. There are lengths of 4, 6 and even 10 in. pipe, all the way from a foot long to two feet. The ends have been welded shut, little doors have been inserted as plugs or even, on occasion, hang on hinges. Draft holes have been cut with torches and then plugged up.

Fill Rooms With Smoke

Lengths upwards of 50 feet of 2 to 8 in. pipe have disappeared from stock piles and scrap heaps, to reappear reaching from these funny little elongated dachshund things on a cold floor up through a hole in the window and up the side of the building—where the landlord would let them get away with it. Sometimes these upward reaching pipes belch large volumes of smoke, sometimes they get so plugged with soot that the belching goes back into the room where the iron dachshund thing is. But always they carry off such a percentage of heat into the cold skies that were these men back home, they would fire without notice any refinery "super" who indulged in such archaic heat losses in the plant.

These heating devices have been constructed both on theory and without theory. Some, one suspects, were "engineered" from McGuffey's Fifth Grade Reader. Some try to burn the dripping, or even the flowing oil, from a ¼ to a ⅜ths and on occasion even a ½ in. brass or copper piping that is connected to a 1, 2, or 5 gal. can on the window sill, either outside or inside. There seems to be no SOP-Standard of Practice on its location. Some of these technical experts with high hopes of much heat use even a 50 gal. drum on the window ledge and one has been reported trying to syphon the oil out of a 2 gal. glass wine jug but drops didn't pull much vacuum.

The liquid is generally gas oil though I heard a hot argument the other day about using gasoline, which, it was maintained, would at least burn.

In some of these iron dachshunds they try to burn the flowing fuel direct and in others drip it onto a small hot plate. The relative merits of this were discussed before, at and after what otherwise was a fine dinner at a real villa—but cold—in the south of France the other day. The nub of it was that an improvised heating affair under a hot water tank built for gas would not warm the water, in fact the cussed thing would not even burn the gas oil.

While the Filipino factotum and his wife tried to keep the meal hot, there crouched in front of this infernal machine Commander Frank Arthur, port tanker captain and old tanker sea captain with

Briton and Yank Work Together in SHAEF Oil Section

Lieut. Col. Stuart R. Jarvis

Col. Jarvis, formerly of Wm. Cory & Sons, shipping agents, is alternate to Col. Norris Fuller, named by Gen. Eisenhower to represent the British Army in the petroleum section for the U. S. Army. He assists Col. Paul of the British Army in the Plans Section. For years he was with Cory & Sons, Ltd., coal and oil exporters, (*See NPN Jan. 17, pgs. 5-6.*)

Capt. Thornton Beal

Capt. Beal, for years Shell Oil Co.'s division operations manager at Spokane, Wash., represents the Civilian Affairs Division (G-5) of SHAEF. His assignment is with Col. S. R. Jarvis, who assists Col. Paul of the British Plans Section. His place in the table of organiza- was explained in the Jan. 17 issue of NPN in Warren Platt's overseas story starting on p. 3.

the Keystone Transportation Co. at Philadelphia and a host; Capt. A. R. Tibor, also a host, of the French Army and in peace European manager and refinery expert for Socony-Vacuum; Lieut. Comm. L. C. Jones of Socony-Vac's staff in far-off China, another host, and Capt. Rudd of various California producing companies.

Before that evening there also had crouched in front of this heater (?) some even wistfully blowing at it, Maj. T. E. Pennington, also an oil man; Lieut. Col. William C. Morgan, internal combustion engine expert; Maj. Grunden of Richfield in California and the Penna. Grade Crude Oil Assn. Lieut. Col. G. B. Maxwell of the Anglo Iranian Oil Co. and, 'tis said, many others.

Those the writer saw trying to make it work presented an imposing though not exactly a thrilling spectacle. They stood, crouched and sat in front of the thing. Some stretched the backsides of their apparel to humpty-dumpty proportions. Others evidently had shivered so long their duds hung loose upon them. Guests were permitted to offer advice, but it was not asked for, and being given, was ignored. No one said "Thank you." The thing burned, after a fashion, with much smoke and smell but no hot water.

Anybody Got Any Ideas?

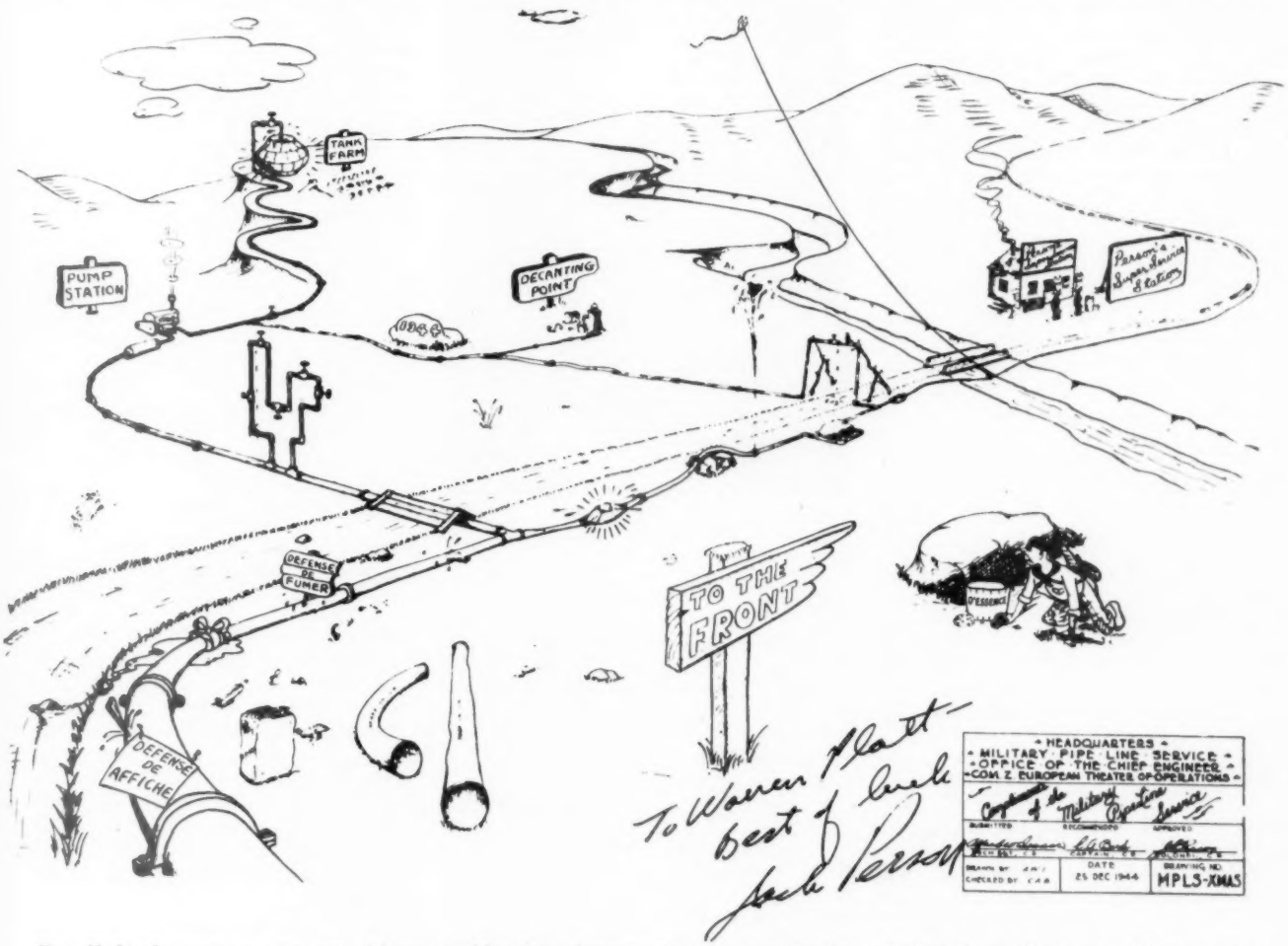
A survey of somewhat similar outfits over these cold areas suggests that the oil industry back home might well lend a helping hand, or voice or a few sketches by which a dachshund could be fashioned that would really heat up.

This technical information, that a fair plumber or garage mechanic could easily assimilate, should be sent to National Petroleum News at Cleveland which will forward it to the chilled brethren over here in the war area.

If any suggestions are considered by sufficiently eminent technicians, as offering a great contribution to the whole industry, they will be printed, not only in the regular weekly edition of NPN but in its special OVERSEAS Edition which goes to all oil men abroad.

New and exceedingly brilliant ideas will be gratefully received and, if they work, duly acknowledged with the thanks of the experts (?) who have been struggling with the problem over here. High college degrees, while not necessarily helpful, will not be counted against the suggestions they are attached to. It is suggested it may be well if the A.P.I. names a committee to start making work-

Pipeline Unit Concocts Humorous Cartoon for New Year's Greeting



Get all the fun you can get out of your troubles, has always been an oil industry maxim, so the pipeliners who have constructed more than 1000 miles of line in northern France in the past six months, put some of their troubles in the above cartoon drawing and sent it out as their New Year's greeting.

Most everyone in the pipeline section collaborated on this effort with more or less brilliant suggestions. At least they all got a lot of fun out of it in part repayment for the vexations of building and operating the line under the most difficult of war conditions.

The one bit of wit they have left off—why I don't know—is that one weary pipeliner after a long, cold and wet day on the line, returned to "Hq" to hear of more troubles, sabotage, etc. and dubbed the whole effort with the name "The Hardly Able Pipeline Co." and that is how it has been affectionately known among its creators.

"Jack Person," who writes his "best of luck" to Warren Platt on the above, is the always cheerful, though sometimes somewhat profanely so, and whimsical, regular Army West Point colonel of engineers who has been the boss of the Military Pipeline Service and has built the line since a few days after "D"-day on the French shore. The writer knows the oil industry joins him in reciprocating, even at this late day after New Year's in wishing Col. Person a daily increasing quantity of good luck and fortune for 1945.—WCP

ing plans for a home-made oil heater that will work for the next war.

All communications on this subject should be addressed to the "Editor of the NPN Mission to France for Relief of Shivering and Helpless Scientific Oil Men," at Cleveland, Ohio.

° ° °

Crandall, Holcomb Released; Planning Period Ended

PARIS—Two more oil men have finally received approval for their return home, their services being no longer needed in the Army since the pipeline and storage planning is about completed and only operation of distribution facilities remains.

These two are Capt. Olin H. Crandall of the Military Pipe Line Service and Maj. Harley J. Holcomb of the POL (Petrol oil, lubricants) Section of Com Z headquarters, Col. Burford's office. Capt. Crandall has been in the Army's engineering service since the start of the war and has drawn many of the working plans for pipelines and storage. He was for years a civil engineer with Magnolia Petroleum Co. of Dallas, where he is returning.

Maj. Holcomb also has served since the start of the war, helping to organize the oil inspecting service and then as a technologist in Col. Burford's office. He is returning to the White Eagle Division of the Socony-Vac where for years he has worked from chemist to chief of the chemical lab. (*See NPN, Jan.* 3, *p.* 6).

A number of other men whose planning services are less needed now that the pioneering is over, have applications in for returning home.—WCP.

Texas Drillers Make Good But Wildcats Are Few

Special to NPN

AUSTIN, Tex.—Drillers' bits are finding pay dirt at a faster rate this year than last in Texas, reports of the Texas Railroad Commission reveal.

Oil well completions during the week ending Jan. 27 amounted to 101, bringing the year's total to 264 compared with 187 during the corresponding period of 1944.

Wildcat operators, however, weren't doing so well. For the week, only one well was a wildcat, making four for the year compared with eight for the same time last year.

Ten gas wells were brought in, two of them wildcats. Ten dry holes were drilled, making 122 for 1945 as compared to 117 for a like time in 1944. Seventy-five wells plugged raised the 1945 aggregate to 223, nearly double that of 1944.

CORRECTION

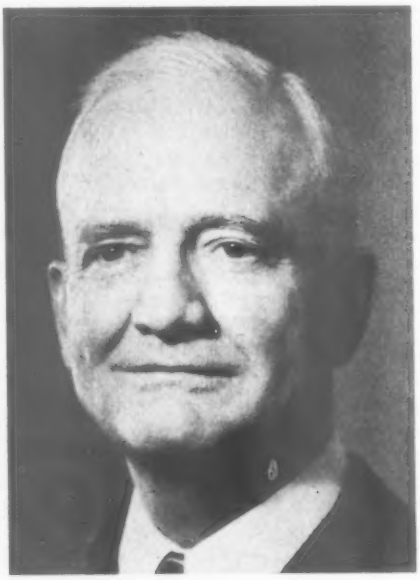
WASHINGTON — OPA announced this week that increases granted four pools because of high production costs will be effective Jan. 1, not Feb. 1 as originally stated. Effective date of increases granted 11 additional stripper pools is also Jan. 1, not Feb. 1. (*See NPN, Jan.* 31, *p.* 11).

Wallace E. Pratt Honored as First Recipient Of Sidney Powers Award for Geological Work

NPN News Bureau

CHICAGO — First recipient of the Sidney Powers Memorial Award of the American Assn. of Petroleum Geologists will go to Wallace Everette Pratt of New York, according to an announcement made here by Ira H. Cram of the Pure Oil Co., Association president. The honor will be conferred upon Mr. Pratt during the annual business meeting of the association in Tulsa on March 27, the presentation being made by Everet Lee De Golyer, past president of the association.

The award will be in two parts, the first being a gold medal containing a portrait of Mr. Powers, and the second



Wallace E. Pratt

an engrossed diploma containing a citation reading:

"For his early and continued contribution to the art of exploration for oil through application of the science of geology and for his advancement of the profession of petroleum geology through his able and friendly skill as an administrator and an executive."

Denison Heads Committee

The award was established in 1943 and is given in memory of the late Sidney Powers, one of America's best known petroleum geologists, referred to throughout the profession as a "geologist's geologist," "in recognition of distinguished and outstanding contributions to the achievements in petroleum geology." A. Rodger Denison of the Amerada Petroleum Corp., Tulsa, is head of the selection committee, made up of 10 association members and two ex-officio members, who chose Mr. Pratt as the initial recipient.

Internationally known as a petroleum geologist, Mr. Pratt is a director of Standard Oil Co. (New Jersey). He is a native of Phillipsburg, Kans. and has been active in geology since 1908 when he served as an assistant on the Kansas Geological Survey. He is one of the preeminent finders and producers of petroleum and an author and lecturer of note, Mr. Cram said in making the announcement, adding that his book "Oil in the Earth" and numerous articles on various phases of petroleum geology are outstanding contributions.

Member of Many Science Groups

Mr. Pratt served with the Bureau of Science in the Philippines from 1909 to 1915, and was chief of the Division of Mines of the bureau when he left in 1916 to return to the United States to join The Texas Co. at Houston as a geologist. Two years later he became chief geologist of the Humble Oil & Refining Co., and in 1923 was elected a member of that company's board of directors.

Subsequently, in 1933, he became vice president of Humble and in 1937 was made a member of the executive committee of Standard Oil (N.J.), becoming a vice president in 1942. When he resigned from the vice presidency, as of Feb. 1, he retained his directorship and membership on the executive committee.

He headed the Assn. of Geologists as president 25 years and is also a member of the American Institute of Mining and Metallurgical Engineers, the Society of Economic Geologists, the Seismological Society of America and a fellow in the Geographical Society of America, American Geographical Society and the American Assn. for the Advancement of Science.

Reports Mexican Oil Find Near Border of U. S.

Special to NPN

MEXICO CITY—Extensive oil deposits now have been found near the U. S. border in the states of Tamalpias and Neuvo Leon, according to Alfonso Cornejo, geophysical engineer of the Mexican Petroleum administration.

Mr. Cornejo did not reveal the exact site of the deposits but said they were less productive than Texas fields. However, he said that the oil is much finer and lends itself better to extraction of gasoline.

Sohio Head Says Enterprise Gave U. S. Oil for War

NPN News Bureau

CLEVELAND—"Free enterprise in America permitted this country to take care of oil needs for war, as well as the needs for a civilian economy", W. T. Holliday, president of Standard Oil Co. (Ohio) said in an address at the Cleveland Oil Men's Club here Feb. 5.

Because of free enterprise, Mr. Holliday said, producers had an incentive for

drilling, and even dry holes were not losses, for they added to the geological knowledge for future production. Under a bureaucratic control system, he asserted, bureaucrats could not take chances of making mistakes.

The money that has been spent in finding oil, Mr. Holliday asserted, actually exceeds the returns received.

He reviewed the developments in the proposed Anglo-American oil agreement, and termed the original plan a "super cartel on an international scale".

Small Business Investigation Turning to Tires and Oil

NPN News Bureau

WASHINGTON—The Senate Small Business Committee is investigating manufacturer-distributor relationships, including ties alleged to exist between oil, tire, battery, farm machinery and other industries.

Investigators are centering attention particularly on matter of tie-ups between oil and tire companies, perhaps with the idea of reviving the old Ellender bill (S. 1122—78th Congress) which would grant independent tire dealers exclusive retail rights on motor vehicle tires. Independent Tire Dealers and Tire Rebuilders of America have again been pressing for action in this direction by Congress.

Also under consideration by the committee is the application of Public Law 549, under which RFC makes loans to small business.

John D. Guy Dies at 71

NPN News Bureau

CLEVELAND—John D. Guy, who spent 50 of his 71 years in the oil business, died at his home in Fort Wayne, Ind., Jan. 19.

Born in Baltimore, Mr. Guy's first position was with the Standard Oil Co. in New Jersey, where he held a responsible position in the refining department. In 1906 he joined the Indian Refining Co. in its first refinery at Georgetown, Ky. He was later transferred to the Lawrenceville refinery, where he remained until 1920, when he moved to New Jersey.

He returned to Fort Wayne in 1931, becoming an independent distributor for The Texas Co., and was operating the business at the time of his death.

He is survived by his wife, two daughters and a son, Dixon, district manager of the Indianapolis district for The Texas Co.

Shell Well Is Near Record

NPN News Bureau

LOS ANGELES—The Shell Oil Co.'s deep test of Signal Hill now has reached 10,059 ft., placing it within 300 ft. of being the deepest well on Signal Hill. Officials said drilling would continue as long as there appeared to be any reasonable prospect of finding a productive zone.

U. S. Owes Debt to Oil That Saved Allies, I.P.A.A. Chief Says

NPN News Bureau

LOS ANGELES — Addressing the members of the Independent Petroleum Assn. of America here on Feb. 6, Ralph T. Zook of Bradford, Pa., I. P. A. A. president, pulled no punches in outlining what, in his opinion, is facing the independent oil producers.

Someone must protect our country against the theorists, bureaucrats and self-appointed planners who would supply the postwar oil requirements of this country from Venezuela, Iran, Iraq, Bahrein, Kuwait or Saudi Arabia, he said.

Other excerpts from Mr. Zook's address:

"Of the problems that are likely to confront us at the end of the war, if not before, two are outstanding—the price of oil and imports. They go hand in hand. An inadequate price for oil brought about by uncontrolled domestic production or from a flood of cheap foreign oil can reduce our domestic oil industry to one of impotence. If that comes about, the very safety of our nation is in jeopardy.

"The potential oil producing capacity at the beginning of this war has been, to a large extent, the source of supply for the ever-increasing demand of the Allied Nations. The Allied cause was saved by the oil reserve and producing capacity of this nation. When enemy submarines had almost completely cut off the oil from the Caribbean area and oil from the Middle East was forced to take the long route around the southern end of Africa because of the almost complete control of the Mediterranean area by the enemy, it was the United States that supplied the oil which enabled the Allies first to check the Axis gains and then begin moving to victory.

"This is a lesson that must never be forgotten. It has, however, been either forgotten or not realized by those who would ruin our domestic oil industry through inadequate prices and unrestrained imports.

Calls for Healthy Industry

"Higher crude prices will go far towards assuring a greater supply of oil for the war and a healthy, dynamic postwar industry. A strong oil industry guarantees the security of this nation in time of war, assures the public of a continuous and adequate supply of oil and products at fair prices, allows the States' natural resources to be released in an orderly manner and furnishes the production branch of the oil industry with necessary funds to accomplish these results.

"There are some who are ready to write off the United States as a strong producing nation and depend on the importation of foreign oil. Others are planning to use the greatest oil market of the world, the United States, to cure the ills of other countries at the expense of our country. The independent producer sees in such thinking a definite threat to his existence.

"If we were to buy all of our requirements from the cheapest source, there would be very little earning power remaining since most goods would come from abroad where wages are but a fraction of that paid in the United States. There is no more logic in saying that our oil should be produced in Venezuela than to say that our steel should be produced and furnished in Mexico, our silver and zinc in South America, our wheat grown in Canada, and our beef supplied from Argentina.

"The consumer of petroleum could readily be harmed rather than helped from such a program. Those few companies who are large domestic producers also hold the largest reserves of foreign oil. They could readily supply their part of the billion barrels of imported oil at an attractive profit from their foreign holdings. The producers, refiners, and marketers who depend on domestic oil would no longer furnish the competition which has made petroleum products one of the greatest dollar values of any commodity purchased by the citizens of the United States. In countries where competition is lacking, petroleum products cost at least 30 per cent more than in this country.

"The domestic oil industry has been on a starvation diet of inadequate price, manpower and materials. Before planning its demise it would be well to turn it loose and give it an opportunity to demonstrate its ability to replace the oil reserves depleted during the war and rebuild the producing capacity of the nation."

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I.P.A.A. Leaders Hear Zook, Order Poll on Subsidies

Special to NPN

OKLAHOMA CITY—The Independent Petroleum Assn. of America executive committee meeting here Jan. 29 and 30, voted to poll its membership on the question of a permanent price differential for stripper well and secondary recovery oil above the publicly posted prices for crude oil. The questionnaire, to be sent to approximately 3000 independent oil producers in 42 states will ask:

"Do you favor a permanent differential in the price of crude oil produced from stripper wells and also by secondary recovery operations?

"If your answer to No. 1 is yes, do you believe such differential in price should be paid by the federal government out of funds raised by general taxes?"

Ralph T. Zook, I. P. A. A. president, in an address before the meeting said, "The number one job of the oil industry is to furnish the oil to win the war, a war that a few months ago seemed to be nearing its end in Europe and was ahead of 'schedule' in the Pacific. Since then we have been faced with the realization that we may be far from the end."

Midwest Refiners and Marketers in OPA Parley On Burning Oil Prices and Enforcement Gaps

NPN News Bureau

CHICAGO — Delivered-at-destination prices on light burning oils in the Midwest, with the tightening of loopholes in rationing and enforcement regulations, took the spotlight here at the end of January when heads of OPA departments in Washington, accompanied by regional assistants, met with about 125 refiners and marketers of Dist. 2.

The original meeting on Jan. 29 was called by John Day, executive secretary of Western Petroleum Refiners Assn., Tulsa, with B. L. Majewski serving as chairman.

A proposed amendment to MPR 88 setting up delivered-at-destination prices on burning oils was presented by Page Keeton, OPA price executive, and after considerable discussion, was approved by the group and taken back to Washington by Mr. Keeton to be redrafted and distributed industry-wide for study before being officially issued.

He explained to the group that the procedure for figuring the delivered prices was similar to that in effect on kerosine since last summer when Am. 15 to MPR 88 was issued; that is, FOB Group 3 ceilings plus freight to destination, the freight rate to be used being the one in effect on Oct. 1, 1941. This was taken to mean that the refiners would absorb the 3% increase that has been added since that time.

Products covered in the proposed amendment are range and stove oil, No. 1 P.W. and Nos. 1, 2 and 3 straw delivered in Standard of Indiana territory, except in metropolitan Chicago and the lower peninsula of Michigan. Re-sellers who had contracts with their suppliers during the base period in 1941 will not be affected by the amendment, it was explained.

With the amendment approved, next step in delivered prices will be to apply them to Diesel and tractor fuels, according to Mr. Majewski.

Going Slow on Interpretations

At the meeting on the second day, William E. Remy, OPA fuel and durable goods enforcement director, told the suppliers that his department would in the future make no separate interpretations of price and rationing regulations, but would get together in agreement with heads of those OPA branches on interpretations before starting any further violation suits against industry. It is believed this will avoid confusion within both OPA and the industry.

OPA enforcement plans a more extensive spot check of price and rationing records of the more important oil companies, Mr. Remy said. He asked that the industry cooperate by keeping a clearer record of individual company pricing systems so investigators would not be unnecessarily delayed and said pricing methods should tie in readily with copies of invoices, and that invoices should avoid upgrading of products to obtain higher prices. He warned against charging higher prices than ceilings, or high prices in the absence of ceilings, with the hope that the higher prices would later be approved by OPA. An inquirer during open forum discussion was told that, even though a higher price was subsequently approved by OPA, it did not void earlier violations.

All ration coupons on both fuel oil and gasoline are now being cleared through OPA verification centers, and Mr. Remy said some outdated coupons for fuel oil, and some that were not yet valid, were being found. He cautioned suppliers against accepting both kinds as they are not legal ration evidences.

Asks Prompt Filing

Regarding gasoline coupons, he said that hereafter OPA will debit dealers with all stolen coupons that they turn in, but those found to have correct car license numbers will be cleared through the 1% bail-out. Not many of that type are anticipated. At various times, coupons have been stolen from ration boards and the plan is intended to catch dealers who buy and turn in sheets of the stolen coupons.

Speaking briefly, John G. Neukom, director of fuel rationing, suggested that suppliers urge their dealers to file shortage claims without delay in order to bring their coupons and product inventory into balance through the bail-out program. To tighten ration loopholes, he said some solution must be found to prevent black market dealers from selling gasoline and other products without taking coupons and then, when their original allotment of coupons and product stocks is exhausted, ceasing operations at that service station and re-opening a new location—where, in the past, OPA has handed them a new batch of inventory coupons.

All three OPA officials complimented the industry for its co-operation with the government agency in helping to get rid of bad operators.

A couple of side issues came up during the two-day meeting. One was the pinch of refiner ceiling prices in the vicinity of Indianapolis, where ceilings are ½c lower than elsewhere over the Midwest. Mr. Keeton told independent refiners there that if they could prove hardship, an adjustment would be considered.

Several refiners from lower Michigan were in attendance at the meeting, and they were called together for a brief separate session after lunch on Jan. 30 to discuss a possible severe shortage of fuel oils in their state before the winter is over. They were asked by Mr. Majewski and A. C. Sailstad, chief of staff, Dist. 2, to send in statistics showing their individual inventory and manufacturing positions so that an attempt may be made to avoid the prospective shortage. All exports of fuel oil from Michigan were discontinued some time ago.

An interested spectator at the various meetings was Walter Hochuli, PAW director of distribution and marketing, who was on hand to answer questions pertaining to those subjects.

Standard 'Cat Cracked' Fuel Oil Blend Urged

NPN News Bureau

CHICAGO—Conservation of burning oils now, prompt provision of additional burners and burner parts and development of a standard blend of catalytic cracked fuel oil were goals highlighted in the address of A. E. Hess, managing director of the Oil Heat Institute, before a local group of about 125 industry men meeting at the Chicago Oil Men's Club Jan. 29. A bright future for fuel oil was predicted by Mr. Hess, provided the industry acts wisely during the present war emergency.

The meeting was the first of a series of 14 which Mr. Hess plans to hold in consultations with the industry across the country from New York to Seattle and back during February. He is scheduled to speak in Oakland, Calif. on Feb. 8, in Omaha Feb. 13 and in Kansas City the following day.

In an effort to obtain a uniform "cat" cracked fuel of the most satisfactory quality, Mr. Hess said, sample fuel tests are now being made in 27 laboratories of burner manufacturers and in seven other laboratories not so closely associated with the industry. The American Society for Testing Materials is co-operating in the tests.

"All the tests, with various types of burners," Mr. Hess said, "will be coordinated and specifications will be determined. Results will be coming in in about two months."

The tests, it was believed, will result in definite specifications for a single type of fuel, which, it was said, would be of service to the public, manufacturers and distributors. Catalytic cracked fuel oils, according to the speaker, have not yet been completely distributed through the country, although limited supplies have reached both the East and West Coasts. Burning units will need more air to take the new fuel than a straightrun product, he said, adding: "Cat cracked fuel won't work out so well in gravity burners."

He thought the industry might need a directive to put a higher priority on replacement parts which are in greater need than new equipment.

In pointing up the future peacetime program, the speaker said the Institute was working toward cohesion "to make it worth what we are going through now." He warned against slipping back into the old pre-war practice of giving free service to get customers.

Various pieces of literature are being prepared by the Institute to answer ques-

tions from the public and for use in training returned soldiers and other new employes. At the proper time, it was hoped that local classes of students would be organized and taught by experienced industry men, using manual now being prepared.

California, Neighbors Escape Brownout

NPN News Bureau

WASHINGTON — Additional exceptions to the order for a national brownout, effective Feb. 1, exempting all of California except the San Diego region and Catalina Island and the greater part of Nevada, Arizona and southern Louisiana, were announced shortly before effectiveness of the order by WPB's Office of War Utilities. At the same time a third exempt area in New Mexico was added to the two others announced earlier.

All exemptions extend from Feb. 1 to June 30.

OWU Director Edward Falck said that compliance with the brownout in the areas exempted "would not result in the saving of any scarce fuels." He pointed out that an appeal of the San Diego Gas & Electric Co. was denied because that firm uses fuel oil for generating power. Catalina Island is served by a Diesel station.

Following are the additional areas now exempted (*for areas previously exempted see NPN Jan.* 31, *p.* 10).

Louisiana: Parishes of Calcasieu, Cameron, Jefferson Davis, Acadia, Vermilion, Lafayette, St. Martin, Iberville, Iberia, St. Mary, Terrebonne, Plaquemines, St. Bernard, Orleans, St. Charles, Assumption, West Baton Rouge, East Baton Rouge, St. John the Baptist, East Feliciana, West Feliciana, St. James, Ascension, Livingston and Pointe Coupee, together with those portions of adjoining parishes in which the only electric energy furnished to consumers is energy transmitted from the system of the Gulf States Utilities Co.

Nevada: Counties of Washoe, Humboldt, Pershing, Churchill, Storey, Douglas, Ormsby, Mineral, Esmeralda, Nye, Lincoln and Clark and that portion of Elko County that receives electric service directly or indirectly from the Idaho Power Co.

Arizona: Counties of Mohave, Yuma, Coconino, Yavapai, Maricopa, Gila, Pinal and Pima.

The additional exempt area in New Mexico comprises that part of the counties of Curry, Roosevelt, Chaves, and Eddy served by the Southwestern Public Service Co.

In addition to actions on major area exemptions, OWU announced the granting of appeals of six electric utilities. Exemptions granted were to the cities of Monroe, La., and Lamar and Pagosa Springs, Colo., the Hillman Light and Power Co., Hillman, Mich., the Copper District Power Co., Ontonagon, Mich., and the Meadow-River Lumber Co., Rainelle, W. Va.

Exemptions were denied the following utilities, because in each case OWU found either that the company used scarce fuel or was interconnected with systems using scarce fuel:

Fosston Municipal Light & Power Co., Fosston, Minn.; city of Fairbury, Nebr.; City Water & Light Co. Hastings, Nebr.; McPherson Water & Electric department, McPherson, Kans., Wyodak Coal & Manufacturing Co., Gillette, Wyo.; Public Utilities Commission, Clay Center, Kans.; Raton Public Service Co., Raton, N. M.; H. P. Gould, Lyons Falls, N. Y.; city of St. John, Kans.; Consumers Public Power District, Columbus, Nebr., and city of Meade, Kans.

Quiz Four Boys in Jersey On 'Little Inch' Thefts

Special to NPN

CARTERET, N. J.—Thefts of high-octane gasoline from the Little Inch pipe line by teen-age boys were revealed last week when agents of the Federal Bureau of Investigation filed charges in a federal court in Newark against four joy-riding high school youths. The FBI withheld the names of the boys, who range in age from 15 to 17.

Samuel K. McKee, chief of the FBI in New Jersey, said the thefts were discovered when one of the boys broke a small pipe through which samples of gasoline had been drawn for tests.

Texan Presents Bills For Gas 'Home Rule'

Special to NPN

AUSTIN, Tex.—Two measures directed at pyramiding corporate structures in the gas and electric utility fields will be tossed into the hopper in the Texas House of Representatives within a few days.

The sponsor, Rep. Marvin Simpson of Fort Worth, admitted his bill might be aimed at the Lone Star Gas Co. but said that the measure would cover a number of other corporations as well.

Rep. Simpson said he had under consideration the possibility of extending the measure to cover such firms as the Chicago Corp., now selling gas from the Corpus Christi area for export, if the bill does not already cover them.

"I am concerned over the fact that companies serving Texas or dealing in Texas gas are so set up that Texas has no real control over them," he said. "Consequently the Texas public pays in its gas and electric rates for a long string of charges and costs involved in the corporate structures which have no real connection with the service given here."

Mr. Simpson's bill would require all directors of gas and electric companies doing business in Texas to be residents of the state and bona fide stockholders, and would require all books and records affecting business in Texas to be kept within the state.

Farm Machines to Fall Far Short of '45 Demand

NPN News Bureau

WASHINGTON — Considerably less farm machinery probably will be sold to farmers during the 1945 crop year than in 1944, despite the fact that schedules call for about the same amount of machinery and attachments, and some $20,000,000 more in repair parts than was produced in the last 12 months.

The reason for this, said OWI this week in a report on farm machinery production and distribution, is that production is running about 25 per cent behind schedule, "because of severe manpower shortages and difficulty in obtaining malleable and grayiron castings and other critical component parts."

The report quoted the War Food Administration as saying, however, that supplies of new farm machinery will not meet essential demands, even if manufacturing schedules are met.

Scheduled for production by farm machinery companies this year are $455,000,000 worth of new machines. In addition, the program calls for $204,000,000 repair parts production and $38,000,000 for attachments. The total 1945 production of $697,000,000 compares with $682,000,000 scheduled for manufacture last year. The 1944 total included: $465,000,000 for new machines; $185,000,000 for repair parts and $32,000,000 for attachments.

Despite curtailed production of farm machinery since 1941, farm mechanization has steadily increased, the report said. It was pointed out, however, that among the key machines which have increased on farms since Pearl Harbor, there are many which have passed their normal period of usefulness and would have been disposed of by farmers "except for wartime conditions." About seven per cent of the tractors and a comparable number of other machines on American farms on Jan. 1, 1945, would have been replaced had new machines been available, the Bureau of Agricultural Economics reported.

Farmers replaced about 100,000 tractors in 1941, the report showed, but the replacement rate has fallen as low as 60,000 a year during the war.

The extent of increased mechanization is indicated by the following Bureau of Agricultural Economics table showing totals of major machines on U. S. farms from 1940 to 1945:

Year	Farm Tractors	Farm Motor Trucks	Farm Autos	Grain Combines	Corn Pickers
1940	1,545,000	1,047,000	4,144,000	190,000	110,000
1941	1,664,000	1,074,000	4,292,000	220,000	120,000
1942	1,844,000	1,135,000	4,500,000	269,000	130,000
1943	1,919,000	1,100,000	4,300,000	298,000	138,000
1944	1,953,000	1,080,000	4,100,000	312,000	146,000
1945	2,072,000	.....	.....	330,000	168,000

PIPELINES—*Views of the Industry's Problems*

Washington— *Congress Sentiment Spells Doom of Big Lending Agencies* —By Herbert Yocom

WASHINGTON — If we judge the temper of the Congress correctly, the unfettered days of the multi-billion dollar government corporation are fast approaching an end.

Mr. Yocom

Legislation just introduced by Senators Byrd, of Virginia, and Butler, of Nebraska, proposes to bring these great instruments of power and influence for the first time under a congressional checkrein, and, as things now stand, the odds appear all in favor of the bill's eventual enactment into law.

This is particularly so for the reason that the measure is said to have the approval of the Treasury Department, the Bureau of the Budget and the general accounting office. On the surface, at least, the fact that these agencies are in support of the Byrd-Butler proposal may appear a bit strange, but it really is not. Like many in Congress, these old-line establishments have looked askance at the growth of government corporations and are now agreed, according to Sen. Butler, that "a definite need exists for Congress to set up a uniform structure" which would limit and define their activities.

The Byrd-Butler Bill would provide this by:

1. Banning the future creation without congressional consent of any new corporation.

2. Making those corporations already in existence—there are 44—accountable to Congress by requiring the annual submission of a detailed budget program for authorization in the same manner as appropriations are made for regular government agencies.

3. Compelling an annual audit by the general accounting office of all financial transactions of the various corporations.

Establishment of some such controls as these has been an aim of Sen. Byrd, particularly, for many, many years. As chairman of the special senate committee on reduction of non-essential federal expenditures, he has made a painstaking study of government corporations and reached the conclusion that their magnitude is now "so great as to rival government proper."

He sees them also as an "invincible competitor" of private business, what with their unlimited government credit at low interest, their freedom from federal, state and local taxation and the prestige that goes with being a government agency.

Sen Butler, too, has some pretty definite ideas on the subject, with a principal aim being that of eliminating the secrecy which up to now has shrouded both the creation and activities of many of these lend-spend agencies. He puts it this way. "Very little is known about these corporations, and although most of them are legitimate, some were created secretly, possibly with ulterior motives."

On that score, of course, the oil industry has had its own experience—with the much-mooted Petroleum Reserves Corp., which was conceived in stealth at an hour that must have been near midnight on June 30, 1943, and for a purpose that to this very day is not yet quite clear.

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According to Vice Admiral Emory Land, boss man at War Shipping, most of the 33 non-self-propelled concrete oil barges built by the government at a cost of $65,588,000 are now being used by Navy in the Southwest Pacific as floating oil storage tanks at advanced bases. The admiral, incidentally, never took very kindly to the concrete ship and barge program for the reason that it was "very expensive and we saved darned little steel" . . . By presidential directive, a fleet of 15,000 American-made trucks are being lend-leased to China for operation as part of a new centralized transportation system . . . Reports going the rounds here are that the Navy is evidencing new interest in the proposed West Texas-to-California crude line which was rejected by PAW Ickes some time ago . . . Because of a couple of remarks dropped by members of the PIWC National Oil Policy Committee at their last meeting, the impression is prevalent in government circles that industry is opposed now to the idea of appointing an oil man or two to the international commission provided for in the Anglo-American agreement . . . Army sources claim a good performance record for the Canol project crude line (Norman Wells to White Horse), asserting that movements during recent weeks have "exceeded expectations" . . . PAW estimates that if the total quantities of oil shipped to date through the Big and Little Inch pipelines had been hauled by tank car, additional cost to the government because of the rail transportation would have been about $225,000,000 on crude and about $100,000,000 on products.

Atlantic Coast— *Leader Forecasts Price Squeeze for Oil Industry* —By Frank P. S. Glassey

NEW YORK—The oil industry faces a period of unstable prices for a couple of years after the war, and oil men will fare relatively worse than those in many other lines of business.

That is the composite opinion of executives in major companies. It was expressed in a recent, frank, off-the-record talk by one of the leaders of the industry. Unfortunately his name cannot be given, for reasons of company policy, but his standing in the petroleum field is so high that his views are set down here as worthy of the most earnest consideration by all in the industry.

Mr. Glassey

"The United States is probably in for a period of inflation after the war," he said. "Major oil companies and jobbers are going to be squeezed between lower sales on the one hand, and rising costs on the other. The outlook definitely is not cheerful. Demand won't be more than 3,800,000 b/d as against current production of almost 4,800,000. The result is that refined prices will drop, unless Government sets a floor on prices, which I definitely do not want.

"Nevertheless the country will be in an inflationary cycle, and crude is one of the best hedges against inflation. Thus the drop in oil prices may be only *relative* to other products. Actually oil quotations may rise, but any evidence will be much less than that for steel and countless other products. But even if the drop in oil prices is only *relative* it will pinch profits, due to rising costs of doing business.

"Another reason for weaker oil prices is that during the war there have been many marketing conditions that might have been altered under normal competitive enterprise. Once the war's over, everybody will try to do something about them, and it certainly won't strengthen prices. There will be readjustments based on competitive processes, rather than frozen processes.

"The reversal of that lower oil price trend will depend on the rate automobiles are manufactured. My guess is that large-scale production of cars will begin three months after the war. There may be 1,500,000 cars turned out in the first year. Within three years production may reach 6,000,000, or 30 per cent above the biggest prewar year.

"Recovery of the oil industry depends to a great extent on how fast the automobile total is built up as compared with how fast cars go into the scrap heap. Once there is plenty of gasoline for civilians the average driver will punish

his car, and they'll go into the discard speedily."

The jobber will have a rough road to travel for a year or so after the war, according to this executive, but he thinks the jobber is prepared for adversity and he believes the major company will do everything possible to aid him.

"Increasing costs during a period of inflation are undoutedly going to hurt the jobber," this man said. "But jobbers know more than they did three years ago. They are better organized, and if they're caught in a squeeze they'll probably squawk to the Government.

"If there is price deflation, the major companies will do all they can to assure the jobber his profit margin. Majors will put pressure on each other for that purpose.

"There is one easy way for the jobber to increase his efficiency in preparation for comparatively lean days that may lie ahead. That is to eliminate discounts. Of course all jobbers will retort that they don't give discounts, but the fact is that they do. The best way to offset rising costs is to cut out discounts, or their equivalent, such as renting a service station at one figure and re-renting it at another."

Most men in so-called big business shy away from any discussion of price cutting. This particular executive was quite open in his belief that so far as the oil industry is concerned prices will be slashed competitively after the war.

"There is no such thing as an uneconomic price war," he said. "A price war is a corrective agency. It's just like a man going to the hospital to have himself fixed up. Occasionally industry needs the hospital treatment only a price war can give.

"Low prices stimulate consumption. Few companies go out of business as a result of price wars, except as they show up mismanagement. Price is the resultant—the stabilizer whereby adjustments are made between supply and demand. Once we again get a period of free competition, major companies may slash prices here and there, and it will do nobody harm, aside from the inherently inefficient."

In this comment, the executive differed from a well-known economist with the same major company, who said:

"I do not think that uneconomic price wars are a benefit to anyone, and in the long run they do not benefit the consumer. Of course this does not apply to cost reductions which are justified by more economical operation."

Returning to the executive's comments, he believes that a further period of consolidations is in prospect after the war.

"The oil industry should view with regret any elimination of companies, through consolidation or otherwise," he said. "But the present tax laws give the small man a great inducement to sell out, and it is only natural that many of the smaller concerns will be absorbed by larger organizations during the next few years."

The service station operator, he asserts, will have an increasingly important job after the war.

"The service station will go much farther than in the past in maintaining cars," he said. "At least one half of the present number of automobiles must be kept on the road until 1949, when production will overcome the factor of obsolescence. The service-station man is the logical one to see that this comes true."

Midwest— *Tank Truck Transporters Facing Golden Opportunity* —By Earl Lamm

CHICAGO—Claim of the railroad tank cars upon the oil industry for future freight business is not without real foundation, but now is the golden opportunity of tank truck transporters if they wish to take advantage of it. With three years of emergency service behind them, especially in replacing tank cars in the Middle West, during which they acquitted themselves with splendor equal to that of the railroads in Eastern service, they have proven ground upon which to stand.

Mr. Lamm

Their daily haul in the country as a whole now is five times greater than it was before the war, or an estimated increase from 595,238 b/d to 3,047,619 b/d for transports of 2000 gal. or better.

Peak tank car delivery to Dist. 1 was about 1,000,000 b/d, which held for a short time only in the summer when fast schedules were at tops with a majority of tank cars in the country in that service.

It is recognized of course that that haul was longer than the average trips by truck and that there are other differences that make the comparison inadequate, such as there being only 16,000 transports compared to 70,000 tank cars; but the figures give a rough idea of the situation.

One point of equal comparison is that both tank cars and trucks are now worn out, and after the war they both start from scratch. It will be largely up to the oil industry as to which gets the business. The trucks will have the help of war emergency pipelines in the long haul, plus the by-passing of many bulk plants or the breaking up of large bulk plant storages into smaller units more widely distributed over each oil company's particular trade territory for convenient pickup by farm and other consumer delivery trucks.

This is likely to cause shifting of many bulk plant locations from railroad to highway property and release bulk plant operators from obligations to the railroads because of cheap right-of-way property leases.

Abandonment of unprofitable short rail lines during the past few years has also forced many bulk plant operators to buy transports that they ordinarily would not have purchased. From here, this is particularly noticeable in the Dakotas and in Iowa, but the state highway departments in many other states are taking the removal of trackage into consideration in their postwar highway construction plans.

How best to handle their opportunity of the future seems to be bothering the transporters. They are not organized into a single group like the Assn. of American Railroads, but like the oil industry, are broken into many small affiliations, each with its own program. Some transporters want to affiliate with the American Trucking Assn., but on the West Coast we understand petroleum transporters have organized separately, and in the East they are doing the same. Operators in the Middle West cannot make up their minds what they want to do.

One argument here is that such for-hire transporters are relatively too few in number to carry the ball for interstate trucking and should join A.T.A. It was recalled that automobile transporters—haulers of new cars from factories to markets—took a licking in 1935-36 when they threw their collective chest out and set up a national organization. They ran into innumerable state barriers—new laws that restricted the length of their transport frames and the loads they could carry, some states prohibiting double decks.

Now, it's pointed out, if petroleum transporters attempt the same type of organization, they will take on the obligation of defending all transport hauling and will put oil companies (who own many transports but who would not be included in the for-hire organization) behind the eight ball if the various state legislatures fail to make permanent the reciprocity that has temporarily lifted many state barriers during the war.

In looking at the future, however, there is one thing truckers of all types can do, particularly transporters. They should get rid of the idea of being in a rut and of being too grateful for the business they receive.

Senate Hearings Delay 'Work or Jail' Measure; Marketers Urged to Seek Locally Needed Label

By J. M. Collins,
NPN Staff Writer

WASHINGTON — The May-Bailey "work-or-jail" bill was tied up in the Senate Military Affairs Committee this week, after passing the House by a substantial majority, and its future was admittedly uncertain in view of divergent opinions expressed by senators as to the sensibleness of such a measure at this time.

However, it appears certain that *some* sort of tighter manpower control will emerge, and that oil marketers and distributors who are not in the "locally needed" class may be hard-hit in areas where war plants are critically short of manpower. On the other hand, a "work-or-fight" act, or whatever solution is finally put into effect, probably will aid other branches of the industry short of men—such as high-octane plants—since they are all in the "critical" class, with the one exception of exploration.

It is possible that instead of a "work-or-jail" bill, Congress may eventually send to the president a bill putting more "teeth" into the War Manpower Commission's voluntary rules and regulations.

WMC's main tool to channel manpower to the spots where it is critically needed rests in placing a "ceiling" on the number of employes a non-essential employer may have, and then transferring to war plants those who are released.

Octane Plants Short of Help

It is obvious that under whatever system results from the current manpower "agitation", non-essential activities and plants will tend to lose employes, the number depending upon the needs of war plants in each area. This points up the importance of distributors—both gasoline and fuel oil—obtaining declarations of "locally needed," in their particular locality. They should immediately contact the manpower counselor in the PAW district office nearest them to discuss the problem and how to go about such a designation.

Meantime, WMC Director McNutt revealed that aviation gasoline plants which are behind schedule because of inadequate labor forces are in urgent need of 2060 additional workers. Production of aviation gasoline was included in a list of 31 critical industries in which 180,000 workers are needed immediately, including 3208 to make tires, and 5900 for the production of heavy trucks.

This announcement by Mr. McNutt tied in with one released on the same day by WPB Chairman Krug which made public a letter sent by him to Senator Thomas, of Utah, chairman of the Senate Military Affairs Committee which now has the House-passed "work-or-jail" bill under consideration.

Mr. Krug urged immediate enactment of the bill by the Senate so that the needed manpower can be channeled to the most urgent war program, which, according to Mr. McNutt's list, includes production of high octane gasoline. Mr. Krug said that in addition to current labor needs, "we know that certain important military programs are expanding rapidly."

Votes for Secret Hearings

It had appeared at first that no extensive hearings would be held by the Senate Committee on the bill, but on Feb. 5 the group voted 14 to 3 to hold closed hearings that may last a week or more. This came after a motion by Senator Chandler, of Kentucky, to hold open hearings had been defeated.

At NPN presstime, War Secretary Stimson, and his assistant Mr. Patterson, along with Navy Secretary Forrestal, were scheduled as the first witnesses before the committee. They are expected to press vigorously for passage of the bill, suggesting that its administration be given to War Mobilizer Byrnes instead of to Selective Service and local draft boards.

Taft Offers Substitute

Pointing up the possibility that the work-or-jail bill may die in the Senate was a remark by Senator O'Mahoney, of Wyoming, who at the beginning of the week declared the entire war situation has changed since military leaders appeared in support of the measure in the House Committee several weeks ago.

"At that time, the Russian drive had not begun," the Wyoming Senator added. "Now the Russians are at the gates of Berlin."

At the same time, Senator Taft, of Ohio, was getting set to renew a fight on the Senate floor to retain the present voluntary system of manpower controls. He planned to offer the substitute of Rep. Harness, of Indiana, which lost in the House by only 10 votes. It would merely give statutory backing to the job referral system of WMC, plus authority to investigate waste of existing manpower in war plants.

The House bill, now before the Senate Committee, contains these main provisions:

Men affected—Those civilians between ages of 18 and 45 not specifically deferred by law, such as public officials, divinity students and farmers.

How affected—If in a war, or war-supporting job, they would be ordered to stick at it. If needed in a more important war job, they would be requested to shift to it, or ordered to, if the request failed to produce desired results.

Essentiality decision—OWM Director Byrnes, or an agency designated by him, after consulting with management, labor, agriculture, and government agencies, would certify to Selective Service the manpower requirements in an area. Non-essential, or less-essential, civilian men between 18 and 45 would be asked by local boards in the area to take jobs in labor-short war plants, giving each man a choice of jobs. In drawing up these "work calls", boards would take into account which men could transfer to jobs with least disruption to civilian economy and themselves.

Appeals—A registrant affected would have to be given a "reasonable choice" of jobs and could appeal a work-order through the regular appeal machinery of the draft boards.

Penalties—A man who disregarded a local board work order would be inducted into the armed forces, if physically fit, or be liable to a fine of as much as $1000, or a jail term of as much as five years, or both—the same as is now provided for draft "dodgers."

In addition to these provisions, a registrant volunteering for or accepting a job under a local board order, would be en-

Report Army To Free Barges For East Coast Denied

NPN News Bureau

WASHINGTON — Government transportation officials this week scotched reports circulating in the industry that the Army would soon release 10 self-propelled oil barges for East Coast civilian service but said there was "a pretty good chance" that a number of wooden barges now idle in Florida waters would be shifted north for harbor bunkering service.

NPN was authoritatively informed that military officials have no plan to release any self-propelled barges since all are now busy in military service, and Maritime Commission officials pointed out that no such vessels have been reported as "surplus" to them, which would be the first step in transferring them to civilian service.

At the same time, transportation officials said no final decision has yet been made on transfer of wooden barges northward since there is still some doubt that they can operate safely and successfully in northern harbors. However, "something probably will be worked out" within the next 30 days, they added.

WAR OIL NEWS from WASHINGTON

HERBERT YOCOM *Bureau Chief*
NATIONAL PRESS BLDG.
NATIONAL 3477

titled to travel and subsistence allowances from his home to the new job if it is in another area. Upon release from that job, he would be entitled to the same benefits for returning home.

A man working in response to a draft board request or order would also be given the same re-employment priority protection as a draftee under Selective Service Law, and be eligible for benefits of the Soldiers' and Sailors' Civil Act if the job he took involved a financial loss to him.

FPC Gets Funds for Rate Cases And for Service Area Work

NPN News Bureau

WASHINGTON — The Independent Offices Appropriation Bill introduced in the House carries funds to enable the Federal Power Commission to commence prosecution of natural gas rate cases for which no formal complaints have yet been filed and to undertake determination of service areas in which natural gas companies may expand facilities without going through FPC certification procedure.

According to testimony presented to the House Appropriations Committee by FPC Chairman Basil Manly, activities in both fields have been under suspension since start of the war.

As a result of the suspension policy, Mr. Manly told the committee, so many gas and electric rate cases have accumulated that conditions have now reached "a point where early action on the Commission's (own) motion is imperative. . . . There are a number of electric cases and some gas cases where the reports to us are showing profits running very high where we have not had a formal complaint filed but which we have been unable to tackle because we have not had the manpower to do it."

OPA Agrees on New 'Bonus' Bail-out Plan

NPN News Bureau

WASHINGTON—Although the idea of a "bonus" bail-out for super-careful gasoline dealers had appeared to be gathering dust within OPA the past few weeks, OPA rationing and enforcement officials have been constantly studying it and this week came to substantial agreement on a plan which they believe is fair and free of mechanical bugs.

Briefly, this new plan, which is identical in principle with that sponsored by industry, provides that if the bad coupons accepted by a dealer (counterfeit, unendorsed, etc.) over a three-months period total less than 1% of his sales during that time, the dealer's past "permanent" debits will be reduced by 25%, or 100 gals., whichever is greater. Thus, it would be possible for a super-cautious dealer completely to erase debits left after taking full advantage of the present bail-out regulations.

For example:

Present bail-out rules generally allow for a 1% slippage in bad coupons. Assuming that during the eight-months period April-through-December, 1944, a dealer accepted bad coupons representing 2% of his sales during that period, and his sales totaled 80,000 gals., debits against his inventory totaling 1600 gals.

The bail-out program, however, has only increased his registered storage capacity by 800 gals. (1%). His local board inventory registration, therefore, is still 800 gals. shy of what it was back in April, 1944, before any debits were entered against it. This, then, is a past "permanent" debit.

Under the plan now tentatively agreed on within OPA, this dealer's "permanent debit" of 800 gals. would be reduced by 200 gals (25%) for each three-months period that his bad coupons total less than 1% of his sales.

As the new plan now stands, a dealer would have to wait for 60 days before applying for a "bonus" bailout; that is, he would have to wait, for instance, until June 1 before applying for a bonus covering sales made during January, February and March. This will be made necessary by the fact that delays in checking coupons sometimes prevent OPA from entering debits against a dealer's inventory until 30 or 60 days after the period for which they are made.

Officials are in agreement on the "bonus" principle and hope that no further delays will be encountered in getting it into operation. The plan will be put on paper within the next few days and circulated among interested officials in the rationing agency. If no objections are then raised, it will be drafted into an amendment to the regulations and sent to higher-ups. If no snags develop, it should be formally issued by OPA about March 15.

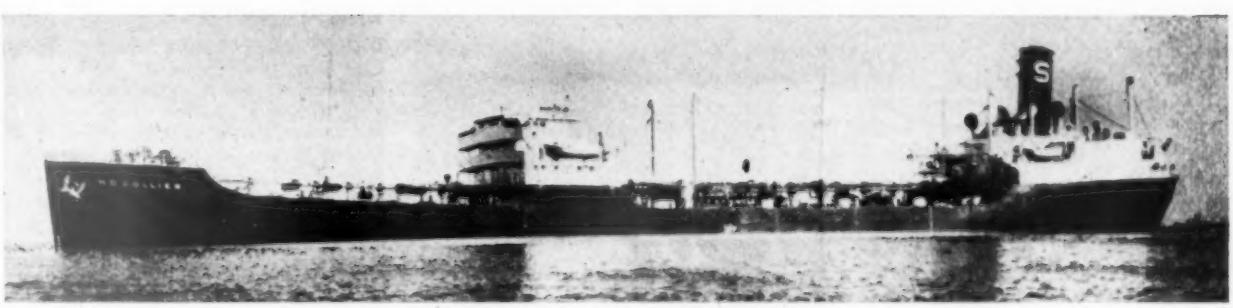
Liquid Cargoes Set Record

NPN News Bureau

WASHINGTON — About 30,000,000 long tons of crude and products and about 2,000,000 long tons of alcohol, molasses and other commodities comprised shipments and receipts of bulk liquid cargo in U. S. ports in 1944, up more than 55% from 1943, WSA announced this week.

Outbound tanker shipments alone averaged 1,750,000 long tons monthly last year, it added, and if the liquids carried were transposed into terms of fuel oil they "would heat an average American home for nearly 8,000,000 years."

33 Die as Enemy Sub Sinks Calstandard Tanker in Arabian Sea



The "H. D. Collier" as she appeared prior to America's entry into the war

NPN News Bureau

WASHINGTON—Submarine sinking of the 12,700 dwt. California Standard tanker, "H. D. Collier," in the Arabian Sea was disclosed this week by WSA.. Date of the sinking was not announced.

Transporting 102,000 bbls. of high octane gasoline when attacked, the vessel burst into flame and 33 merchant seamen, including the tanker's master, Capt. Joseph Fox, Oakland, Calif., were fatally burned as they attempted to launch a lifeboat.

Fourteen survivors in a second lifeboat later were rescued by the "SS Empire Raja."

The tanker's chief mate, James E. O'Brien, of Oakland, Calif., later received a letter of commendation from Vice Admiral R. R. Waesche, U. S. Coast Guard commandant, praising his "exceptional performance of duty under emergency conditions."

The "H. D. Collier" was built in the Chester, Pa., yard of the Sun Shipbuilding and Dry Dock Co., in 1938.

Four Big U. S. Agencies Join to Warn Nation 1945 Will Be Worst Automotive Year

NPN News Bureau

WASHINGTON — The hardest year since the start of the war for private motorists and for passengers, customers and operators of truck and bus lines was forecast this week by four main agencies of wartime government, whose findings were co-ordinated by the Office of War Information.

The combined report laid special stress on the fact that 1,500,000 more of the nation's diminishing fleet of 24,400,000 civilian autos would pass out of active service in the course of the year, continuing a process of deterioration and breakdown that took about the same number off the roads in 1944.

A shortage of lead, compelling a greatly reduced allowance of the metal for use in batteries for civilians is the greatest threat in the transport situation and will require increased conservation efforts like those now being made with tires, the report indicated.

Institution of thousands of new "share-the-ride" pools was suggested by OWI as a probable necessity to conserve the nation's hard beset auto transport.

Data for the report were supplied by ODT, WPB, PAW and OPA, with additional material from other government agencies. Its main findings follow:

THE GASOLINE SITUATION

Even though certified production of all petroleum liquids for February, 1945 (5,074,850 barrels daily) is at an all-time peak and the current production of all grades of gasoline is also at a record-breaking total, the problem of gasoline supplies for civilians remains acute. This represents an increase of 34,050 barrels daily over the production certified for January, 1945, and surpasses the former all-time high certification of 5,051,300 barrels daily for September 1944. Reason for lack of improvement: Military demands have expanded along with increased production.

Substantially all oil fields in the United States are operating at maximum or above maximum efficient rates. United Nations oil countries, from which imports are obtained, are also at maximum flow.

Military requirements are currently on the increase. At the present moment, transportation is tighter than supply. Every car, barge, tanker, and pipeline is being used to capacity—the greater requirements for military supplies during the past six months making the movement of civilian supplies more difficult.

No Increase In Sight

The gasoline allocation of PAW to ODT for the first quarter of 1945 amounts to 986,000 barrels daily. This meets ODT's estimated requirements except for a slight decrease in the East Coast and West Coast districts. PAW indicates that because of the continuing high level of military demands and the current shortage of transportation facilities, it was unable to meet East Coast requirements by 9,000 barrels daily and West Coast requirements by 2,000 barrels daily. The same conditions prevailed in the final quarter of 1944.

The Foreign Economic Administration reports that gasoline exports from the U. S. (lend-lease and commercial sales, but excluding all military) amounted to 15,700,000 barrels in 1944.

Col. J. Monroe Johnson, ODT director, made the following comment about gasoline supplies and the condition of the nation's gasoline-powered automotive vehicles:

"The Office of Defense Transportation claims for civilian use all the gasoline that it estimates is required to keep the nation's essential private transportation properly functioning. Because of the shortage of tires, parts and new vehicles, there is no immediate prospect that ODT will increase its claims for gasoline for civilian use."

OPA reports that there are 22,800,000 "A" gasoline ration holders. 8,800,000 "B" book drivers and 5,600,000 "C" book users.

Gasoline allocations for passenger cars are based upon an ODT estimate that the essential transportation work of each automobile can be performed with an average mileage for the nation of between 5,000 and 5,500 miles a year. The average annual mileage before the war was 9,000 miles.

The country's pipelines, PAW reports, are now carrying into critical shortage areas more petroleum and products than any other single medium of transportation.

Increased demands for gasoline for use abroad are expected from the Near East and Middle East late this year. If the war's pace should slacken late in 1945 or if "Victory-in-Europe" Day should arrive at that time, some surpluses may be available for civilian use depending on a decrease, if any, in military demands. Officials cautioned, however, that more liberal rationing of gasoline after "V-E" Day is contingent on a number of factors.

Consumption of gasoline has recently been running slightly higher than allocations, meaning that the nation is using reserves, according to PAW. Military forces are taking tankers. Because of current urgencies, some of these are being used for floating storage facilities. This takes tankers out of circulation for repeat deliveries.

The over-all reduction in gasoline for civilian use is 33 1/3 per cent since the start of the war. Inasmuch as the reduction for farmers and commercial vehicles has been less than that for passenger cars, the ordinary motorist has taken more than a 33 per cent cut in gasoline.

Gasoline available for civilian use today is of the standard and quality of that which prevailed several years ago—70 octane. Easy-starting elements (butane, etc.) have been reduced.

There are not so many tank cars available this year as there were a year ago. Approximately 75 tank cars are lost each month because of complete depreciation, fires, wrecks, breakdowns, etc. Several thousand tank cars are now awaiting repair. Manpower shortage (600 repairmen needed) prevents speeding up of these repairs.

Total U. S. stocks of civilian grade motor gasoline as of Jan. 13, 1945, according to PAW, amounted to 45,090,000 barrels. Stocks in the same category as of Jan. 15, 1944, totaled 24,999,000 barrels.

The average ODT distribution of automotive gasoline among the various classes of users in number of barrels daily during 1944 follows:

Passenger Cars	561,135
Trucks	360,272
Local Commercial Transport and Intercity Buses	72,203
Water Transportation	10,612
Railroads	1,242

The Petroleum Administration for War

Fred G. Jackson Named Foreign Supply Aide

NPN News Bureau

WASHINGTON — Appointment of Fred G. Jackson, of Houston, Tex., as assistant director of PAW's foreign supply and distribution division was announced over the week-end by Deputy PAW Davies.

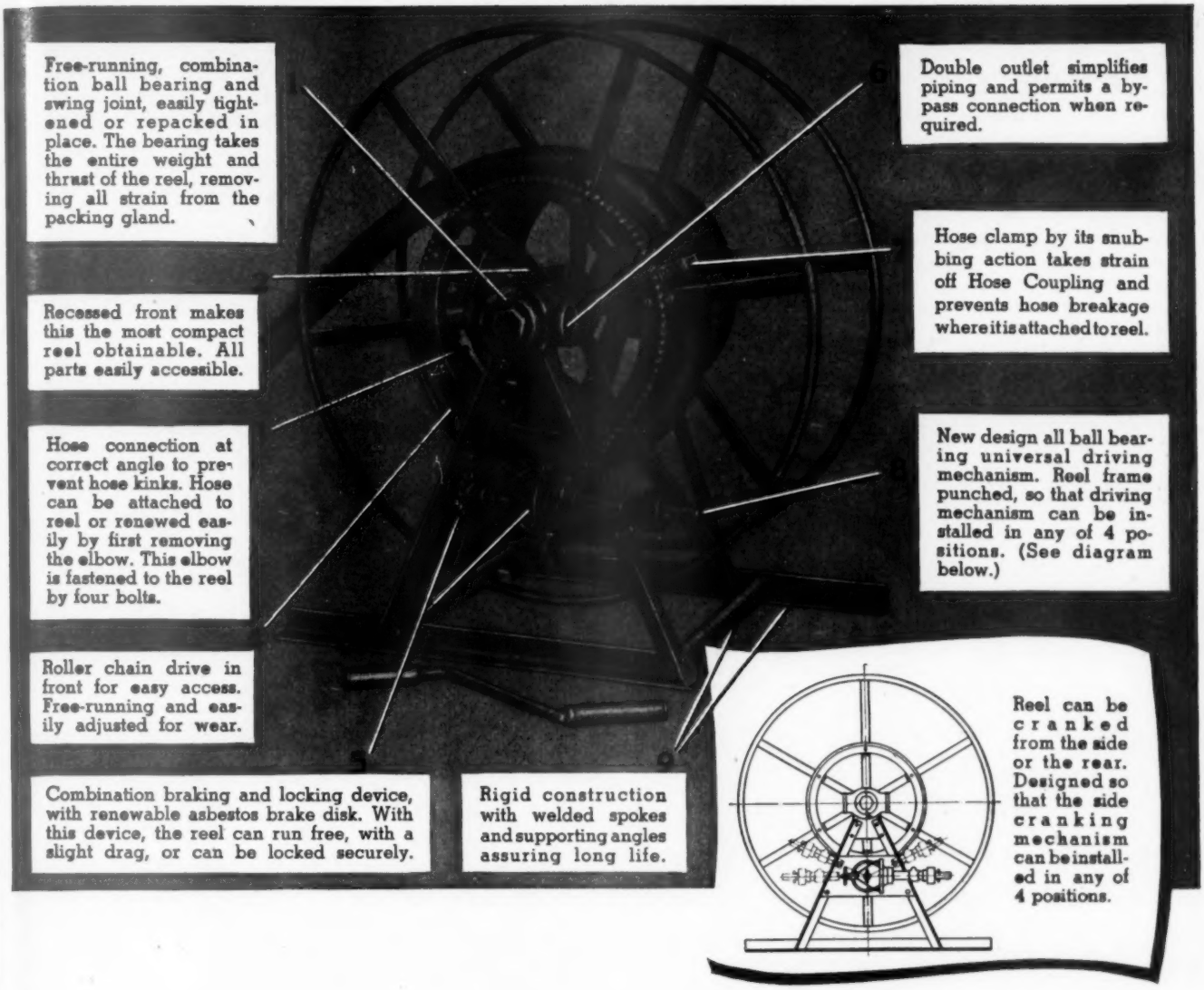
Continuing as PAW's Canadian representative, in which capacity he works very closely with the Canadian oil controller's office, Mr. Jackson will also administer scheduling and planning of the distribution of foreign crude oil.

With a background as an oil man in Europe, South America and the United States, Mr. Jackson was a private petroleum consultant in Texas for seven years prior to his appointment to the PAW staff on Dec. 16, 1943.

After graduating from Marietta College, Marietta, Ohio, in 1918, he worked for the Carter Oil Co. Four years later, he transferred to Romano-Americana Co. in Romania, serving as production foreman and later as district superintendent before returning to this country in 1931.

He attended Columbia School of Business Administration, receiving a master's degree that year. In 1933, he spent a year in Venezuela, working for the Creole Petroleum Co., later returning to Texas and then joining PAW as a petroleum consultant.

Fred G. Jackson


Free-running, combination ball bearing and swing joint, easily tightened or repacked in place. The bearing takes the entire weight and thrust of the reel, removing all strain from the packing gland.
Recessed front makes this the most compact reel obtainable. All parts easily accessible.
Hose connection at correct angle to prevent hose kinks. Hose can be attached to reel or renewed easily by first removing the elbow. This elbow is fastened to the reel by four bolts.
Roller chain drive in front for easy access. Free-running and easily adjusted for wear.
Combination braking and locking device, with renewable asbestos brake disk. With this device, the reel can run free, with a slight drag, or can be locked securely.
Rigid construction with welded spokes and supporting angles assuring long life.
Double outlet simplifies piping and permits a by-pass connection when required.
Hose clamp by its snubbing action takes strain off Hose Coupling and prevents hose breakage where it is attached to reel.
New design all ball bearing universal driving mechanism. Reel frame punched, so that driving mechanism can be installed in any of 4 positions. (See diagram below.)
Reel can be cranked from the side or the rear. Designed so that the side cranking mechanism can be installed in any of 4 positions.

The New Hose Reel You Have Been Looking For

COMPACT, RUGGED, LIGHT IN WEIGHT, BALL BEARING CONSTRUCTION THROUGHOUT

The new Philadelphia Valve Co. reel is the finest reel built. It is compact, rugged, and light in weight. All parts are of steel, malleable iron, or bronze; no cast iron is used. It is ball bearing throughout with hardened and ground races. (6 ball bearings are used.) It will never wear out.

The reel can be changed from top winding to bottom winding by reversing the hose connection and rotating the drum. All working parts and hose connections are in front and easily accessible. It is light in weight, a reel that holds 100 feet of 1½" hose, only weighs 93 pounds.

We can furnish hose reels in any size or shape. They can be furnished for installation either in bucket box at rear of truck or in underslung box on side of truck. Give inside dimensions of box when writing for information. Special reels can also be furnished for Airfield Refueling Pits and Ship Docks.

Delivery can generally be made in a few days after receipt of order. For sizes, prices, and dimensions, write for Catalogue No. 165.

PHILADELPHIA VALVE COMPANY

ARAMINGO AVENUE AND ONTARIO STREET, PHILADELPHIA 34, PA.

Pacific Coast Distributor: Oil Marketing Equipment Co., 325 Fremont St., San Francisco, Cal.

gives the following tabulation of the total U. S. refinery production of all gasoline (including the aviation type) since 1941:

U. S. Refinery Production in Barrels Daily*

1941	1,839,000
1942	1,608,000
1943	1,623,000
1944	1,975,000
1945**	2,100,000

*Each barrel of crude oil contains 42 gals.
**Estimate

Of all gasoline currently produced, PAW reports 35.2 per cent goes to the armed forces; 30.8 per cent for trucks, buses and farm vehicles; 34 per cent for civilian passenger cars.

THE TIRE SITUATION

With tires carrying more freight and passenger traffic today than ever before in history and with military mechanization requiring more and more tires, the problem of producing enough tires for essential civilian and military transportation is acute, ODT officials emphasize.

Rubber requirements have steadily increased since 1939. Consumption was 600,000 tons in 1939; 700,000 tons in 1944 despite sharply curtailed use for civilians. Production of synthetic rubber in the United States during 1945 is scheduled to exceed 1,000,000 long tons, the bulk of this tonnage being reserved for the manufacture of tires.

The armed forces now need about 30% more tires than they are getting. The military hopes to get approximately 20,000,000 heavy-duty tires in 1945, or about 10,000,000 more than in 1944. The production of 28,000,000 heavy tires in 1946 will double the 1944 output, which totaled 14,000,000 truck and bus tires. There are two million American-made military vehicles rolling on rubber throughout the world.

Officials point out that military tires undergo rough use in all war theaters. These tires do not roll over smooth concrete, but jounce over ruts, sand, rock and the debris of war. Tin cans, shell fragments, broken glass, shattered parts, rubble and bullets are normal hazards of the tire on war duty. Roughly, three out of every five tires replaced in France suffered from carcass damage rather than from wear to the treads.

Tires on airplanes also endure heavy punishment. One eighth of an inch of rubber may burn off the tires each time a plane comes down. Generally, airplane tires are good for from 150 to 200 landings, but many plane tires are ruined the first time they strike the ground. Each injured tire must be replaced, since planes can't take chances on blowouts.

Bad Year for Civilians

In the face of multiplied military tire requirements, the nation's civilian owners of passenger automobiles will have to endure another year of stringent rationing. WPB has reduced the quota for civilian passenger car tires in the first quarter of 1945 from an anticipated 8,000,000 tires to 5,000,000 tires, because heavier emphasis is being placed on the output of tires for light trucks and jeeps.

During 1944, OPA had 17,475,000 new passenger car tires to ration. In 1943, it had 13,250,000 new passenger car tires; in 1942, exactly 3,500,000.

The following reductions were made necessary in the monthly rationing quotas for January, 1945, as compared with December, 1944:

Passenger car tires, Dec. 1944, 2,000,000; Jan. 1945, 1,800,000; change −200,000.

Small truck and bus tires, Dec. 1944, 280,000; Jan. 1945, 216,000; change −64,000.

Heavy truck and bus tires, Dec. 1944, 120,000; Jan. 1945, 110,000; change −10,000.

These quotas were ordered reduced despite the existence of a backlog of high-priority civilian truck tire applications which remain unfilled. More than 90% of the large tire purchase certificates issued have gone to trucks with top eligibility rating, ODT explained.

WPB's tire figures follow:

Total number of passenger car tires produced during 1944 reached 18,931,000. Tires released to OPA for civilian rationing during the year reached 17,475,000. The total production figure includes passenger car tires for direct and indirect military use.

The first rationing measure instituted in America was adopted to conserve tires. Subsequent curbs were not based on tire conservation but on gasoline shortages. Tire rationing and other conservation measures enabled us to extract three years' service from a single year's normal supply of casings and inner tubes.

A highly competitive market in 1941 prevented the tire production crisis from becoming more acute than it is today. In 1941, the last year before tire rationing began, 19,400,000 tires were placed on new passenger cars and 34,100,000 tires were shipped into the replacement market, making a total of 53,500,000 new tires of sizes used by passenger cars. The result was that the market was oversold and there were substantial stocks in the hands of dealers and private individuals.

The tire manufacturing picture remains gloomy with shortages of rayon and cotton cord and carbon black described as severe. Natural rubber on hand must go to fill the needs for heavy duty tires. There is an insufficient number of workers in tire plants, too, thus aggravating the tire situation even more.

Rayon and Carbon Black

WPB commented as follows on the rayon cord and carbon black problem:

"The situation in carbon black continues to be tight. An inadequate supply of easy processing channel and high-modulus furnace types will have to be balanced by the use of less desirable furnace blacks.

"The situation in high-tenacity rayon cord probably will remain the most serious bottleneck in the tire program. The rayon industry will fall short of meeting essential material needs in the first quarter by 19,100,000 pounds. Plans are being made to expand production in the subsequent quarters.

"Because cotton tire cord will have to be substituted to cover the deficiency of rayon cord on a poundage ratio of 1.3 to 1, cotton cord needs for tires will

(*Continued on p. 44*)

'Gas' To Power MacArthur Drive Landed on Luzon Beach

Press Assn. Photo

The beach at Lingayen Gulf is covered by drums of gasoline as more fuel arrives by barge from the supply fleet hovering off shore to fuel American tanks, trucks and other equipment for the drive of Gen. MacArthur's forces on Luzon Island

"BH" means BEST HOSE

for tank truck service

there are *3 reasons why*

1 Finest quality synthetic rubber tube, unaffected by gasoline, propane, butane or oils. Non-swelling. Non-cracking. Smooth bore—fast delivery.

2 Reenforcing plies of horizontally-braided, high tensile cotton cord—with strand of static-conducting wire braided in. Highly resilient—resumes normal shape if accidentally flattened.

3 Super-tough, smooth, synthetic rubber cover. Abrasion, sun and weather resisting—slow wearing. Yet it's a soft type flexible hose.

NOW AVAILABLE FROM YOUR GOODYEAR JOBBER

STYLE **BH** TANK TRUCK HOSE

GOODYEAR

THE GREATEST NAME IN RUBBER

Should the Credit Card Business Be Restored?

Other Wholesalers Don't Carry Charges for Retailers, Jobber Says

As Told to Herb Taylor, NPN Staff Writer

As the controversial credit card question enters its fifth week, with opinions on both sides rolling in, the president of a leading independent oil jobber company expresses his opinion and gives the jobber's side of the picture as he sees it. He permits use of his name.

Also, in the accompanying article, the credit manager of a leading western oil company, whose name is omitted by request, favors credit cards, one of the first credit executives to do so.

Conversely, the credit executive of a southern integrated oil company, tells why he is opposed, though his company formerly had a tremendous credit card business.

We will be glad to have the opinion of other readers, particularly independent jobbers.

William R. Pate, president of Pate Oil Co., independent jobber of Milwaukee, operator of "Hello Neighbor" service stations, feels that several vital points have been overlooked in our articles on credit cards so far. Here is this independent jobber's thinking on the subject:

"First of all, oil companies are considered 'wholesalers' and in what other fields do the wholesalers carry charge accounts for the retailers? Since oil companies are wholesalers, and since their stations are leased in normal times, their products would not represent 50% of the purchasers going through the station.

"An independent jobber in Wisconsin averages 2¼c per gal. as a wholesaler. When he sells to his retailer, the tax and the dealer's spread immediately are added to the price, so a wholesale price of 10.6c immediately becomes a retail price of 20.4c, so in the final analysis the wholesaler is buying at one hundred cents on a dollar charge that represents twice his original sale. Now if these sales represent only 50% of the retailer's business, it would appear that the oil company is not in a comparable position with the department store, as one of the sales managers so glibly compared it.

"In view of these facts, the only incentive I can find for a major oil company carrying service station charge accounts for his retailer, is in order to shut out independent competition because the independent, selling under his own brand and at major oil company prices, cannot possibly operate his marketing on a losing basis, whereas a major oil company, with savings at the refinery and on transportation, can naturally operate his marketing on a losing basis, and the most legitimate appearing way to do this is by carrying charge accounts for his retailers or his distributors.

Says Retailer Subsidized

"Large oil companies feel at times that they are singled out for investigations and that these are not fair to them. Now put yourself in the place of an independent who has his life's savings in his business and is trying to operate efficiently on 2¼c, and along comes his major competitor and in many cases gives a cent a gallon rental and carries all the charges of the retailer. Immediately he is rendering to that retailer a service worth an additional cent, so in fact, he is subsidizing that retailer to the point where he has more than 6.4c a gallon under the service station selling price. Yet, that same major will go out in the state and insist that his wholesale distributor should be satisfied with 5½c.

"Now what about the independent selling under his own name and brand compared to the major distributor? The major will still furnish advertising and carry the charge accounts of this distributor, whereas the independent must carry his own charges to be competitive and must pay his own advertising expense and, naturally, purchase his own globes and other advertising display equipment.

"Frankly, I believe the large oil companies and the independents would get along together fine if the oil executives would consider that they were essentially in the wholesale business and act as wholesalers and if their retailers wanted to carry charges, that is another point."

Yes, Says Western Credit Manager

Here are the views of a western company credit manager favoring the cards:

"The important question, regardless of your opinion or mine, is 'Will the Credit Card Business Be Restored'? No one will deny that most consumers who have used credit cards will favor their return when the travel restrictions are lifted. Will this demand be left unsupplied?

"Before answering this question your reply should be based on conditions as they most certainly will exist in the future when petroleum companies will have a surplus of all commodities and will be anxious to develop larger sales.

More Accessory Business?

"Does the credit card actually develop more business: It seems to be the consensus among service station managers and supervising sales executives that it is easier to sell a customer more in the way of accessories and services on a credit basis than it would be on an 'out of pocket' cash basis.

"But what about gasoline and oil? Will a customer take a trip or drive farther if he can make his purchases on credit? In some cases—yes. In others—no. The answer to this question depends to a great degree on economic conditions. In any event we know that all industries are directly or indirectly competing for the consumer's dollar. Why not make it easy to purchase those commodities and services sold at service stations?

Sales Promotion

"Retail stores under ordinary conditions welcome credit business. Many even attempt to convert their cash business to a credit business. Why? The answer is to promote greater sales. These stores also have a high cost of handling charge sales.

Advertising

"Large sums of money are spent on advertising by companies in the oil business. Does the fact that thousands of consumers carry credit cards of a company—receive monthly statements in which may be enclosed a folder promoting the sale of some product, have any significance? If so, at least some of the high cost of the credit card system is a justifiable charge against the advertising budget.

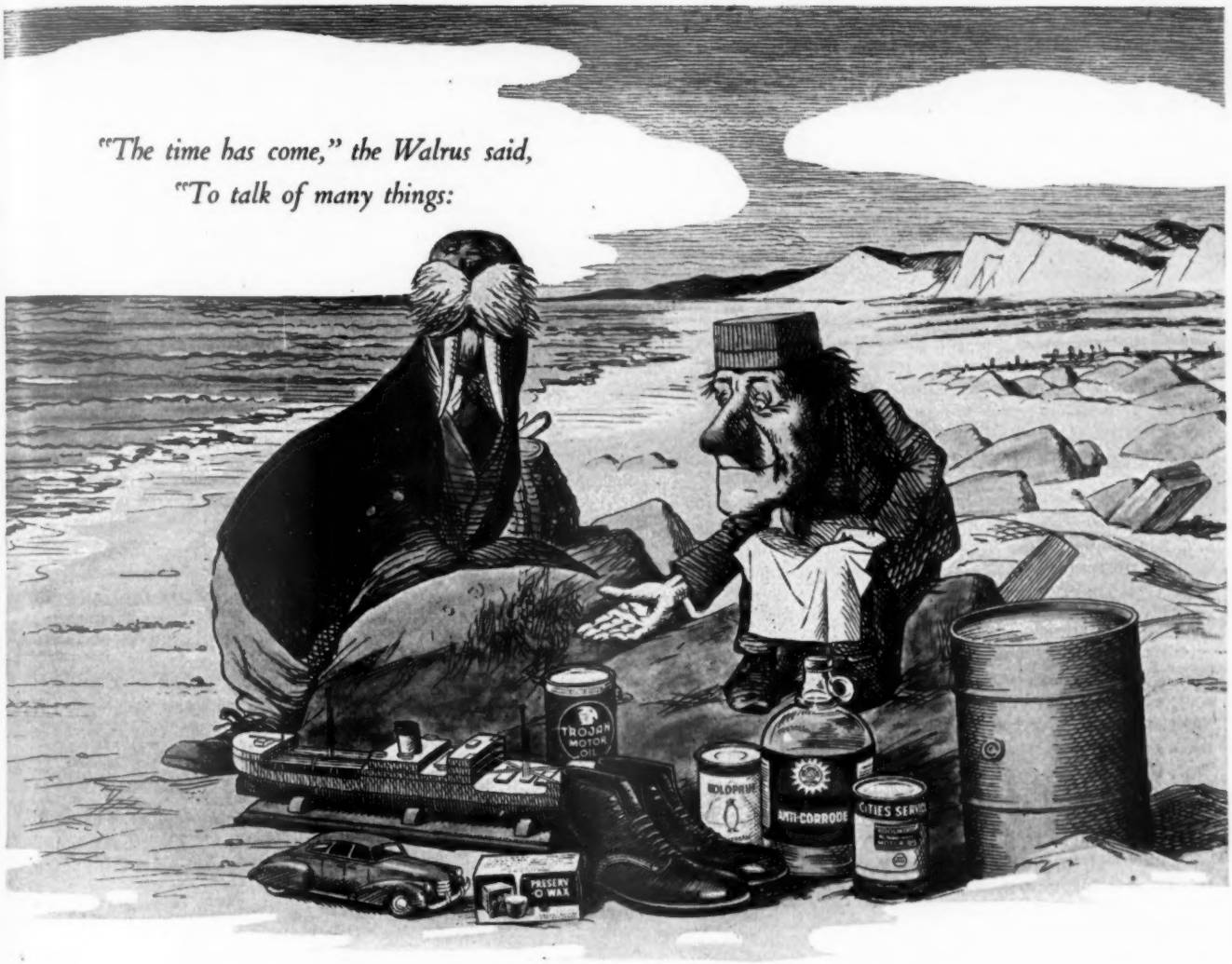
Competition

"The public has been nurtured on credit and expects credit in the future. They will undoubtedly get it in the form of the credit and card system. If not, they will secure credit from individual station owners who are adequately financed. Competition will force oil companies to finance those dealers who do not have sufficient capital so they can extend credit. Credit men know the dangers of individual station owners extending credit and how it contributes to their downfall.

"Most oil companies have well formulated plans for re-establishing the credit

'Nuisance,' In N. Carolina

NPN is carrying a series of very interesting discussions, pro and con, on the question of credit cards. On the whole, argument leans heavily against resuming these cards, in line with the feeling of most dealers and jobbers in North Carolina that they are largely a nuisance, and should be dispensed with not only for the duration but forever.—*N. C. Oil Jobbers Assn. Bulletin.*



Of shoes—and ships—and sealing wax—"

What Alice found "through the looking glass" was no more wondrous than the new world of petroleum as seen by Cities Service scientists...In this true Wonderland of Research the black gold of oil serves an ever-growing list of needs...Yes, it polishes SHOES ...and powers SHIPS...and SEALS preserves...and does a lot of other things that hold bright promise for tomorrow.

IN this war, Cities Service is represented on the battlefronts with everything from gasolene and lubricants to highly developed specialties, such as Cities Service Anti-Corrode, Insecticides, Detergents, Plastics and Explosives.

And to this list we have recently added tremendous quantities of 100-octane aviation fuel—enough to send great fleets of heavy bombers over Germany every day—as well as enough butadiene capacity to supply one-eighth of the nation's normal rubber demands. Such are the amazing production figures of the new Cities Service Refinery at Lake Charles, Louisiana—one of the world's largest and most modern refineries devoted to Victory!

When peace comes, you can look to Cities Service for important new developments. For the beginnings of this company go back almost as far as the Petroleum Industry itself!

In the future as in the past, Cities Service will continue to pioneer.

Progress through Service—

card system so the real question is 'When will the Credit Card Business Be Restored?'"

No, Says Southern Credit Executive

A Southern credit executive dissents as follows:

"I am not in favor of the return of credit cards, in any form, for the individual car owner. I would, however, favor their retention for the fleet operator. In my opinion, the average car owner has not been inconvenienced by not having a credit card. If so, certainly not to the extent of the service station attendant on whose shoulders rests the responsibility of all the accounting work required to handle the charge tickets; not speaking of the cost of this work in the accounting department of the general office.

"It would be impossible to control credit cards if they were issued to motorists on a limited basis. For example; to be used on distant trips. The employes of the entire oil industry couldn't furnish a police force large enough to prevent wholesale violation.

"I have made a survey of a large number of dealers and 90% do not favor their return except for fleet use. These dealers say there has been no appreciable increase in the accounts they are carrying. It always has been their practice to carry accounts for a certain group of regular customers and friends.

"The manager of our largest service station, which is located in a residential section and whose patronage consisted of a very large per cent of individual credit card holders, has estimated a 25% personnel time loss by writing out and accounting for the charge tickets. This business, of course, represented mostly small sales averaging approximately five gal. Had this business come altogether from fleet owners, the deliveries would have been large enough to justify the time loss.

"The cost, from an accounting standpoint, is only one of the factors involved. Before the restriction was placed on credit cards, our credit loss in this end of our business averaged approximately 5%. Other oil credit men, to whom I have talked in this area have suffered greater credit losses.

"The motorist on long trips could resort to the use of coupon books to offset the inconvenience of carrying large sums of money on his person."

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A.C.S. Cancels Spring Meeting

NPN News Bureau

NEW YORK—The annual spring meeting of the American Chemical Society will not be held this year, it was announced here by Dr. Charles L. Parsons, secretary of the society, following action by the board of directors. Dr. Parsons explained that practically the entire membership of the society is engaged in essential war work. He added that the society desires to co-operate with the government in meeting transportation difficulties.

Indiana Standard Transfers Bank Set Up in Panic Days

Special to NPN

WHITING, Ind.—Standard of Indiana has transferred ownership of the State Bank of Whiting to W. R. Smith, its vice-president and cashier. The bank was organized on Dec. 11, 1931, to safeguard the funds of refinery employes in this area through the panicky days of the depression, Mr. Smith said, when one bank failure here indicated that others might occur. The Standard of Indiana's big Whiting refinery is nearby.

When the bank was formed in 1931, Mr. Smith was an employe in the treasury department of Indiana Standard in Chicago, and he was transferred to the banking activity in his present capacity of vice-president and cashier. E. G. Seubert, president of Standard, became also president of the new bank.

"From the start," Mr. Smith said in announcing his new ownership of the bank, "it was recognized that banking was not a natural activity for Standard Oil, and it was planned that when all reason for the company to stand behind the bank was ended, it would fade out of the picture."

New England Independents Hear Army Major and Editor

Special to NPN

BOSTON—The fifty-first annual meeting of the Independent Oil Men's Assn. of New England was held at the Hotel Kenmore in Boston last month.

John W. Scott, association president, opened the meeting and presented Clyde G. Morrill, executive director, who in turn presented Maj. George Kimball, a soldier from the China-India theater of war, who directs transportation of supply in that area for the Army.

Another guest speaker, Richard Doherty, state conservator of the fuel oil division, Committee on Public Safety, outlined conditions in the state, and reviewed work his office is doing in connection with the governor to maintain a proper fuel oil supply.

Robert Gray, business manager of Fuel-oil and Oil Heat magazines, New York, was the speaker of the evening, discussing "Oil Heat and Your Plans for the Future."

The following officers, directors and advisory board members were elected:

John W. Scott, president, Buckley & Scott Utilities, Inc.; Glenn Arnold, vice-president, Petroleum Heat & Power Co.; Paul Strang, secretary, Community Service Stations, Clyde G. Morrill, treasurer, Boston.

Board of Directors: Fred Bergfors, Quincy Oil Co.; Warren Keith, Keith Oil Co.; John Birmingham, White Fuel Corp.; Phillip Dalrymple, Dalrymple Oil Co.; Wesley Downing, State Fuel Co.; Harold Hadley, Walker Coal & Ice Co.; Geo. F. Williams, Petroleum Engineering Corp.; Geo. LaPointe, Manchester Petroleum Board of Trade; George Stetson, Valley Oil Co.; Fred Wetstine, Goodrich Oil Co.; Harold Harrup, Park Oil Co.

Advisory Board: Louis I. Allen, Brattlesboro, Vt.; J. Whitney Bowen, Jos. A. Bowen Co.; Robert Carney, Carney-Young Utilities, Inc.; John Gill, Petroleum Heat & Power Co.; B. L. Hallinan, Hallinan Bros.; Frank Hennessey, Lincoln Oil Co.; Arthur Kimball, Metropolitan Ice Co.; Floyd E. Knox, Oil Service Co. of New England; Ralph Lull, Oilmen's Service & Supply Co.; Fred C. McKenney, Lewiston, Maine; William C. O'Meara, Quincy Oil Co.; James C. Scanlan, Pennsylvania Oil Co.; Chas. Shaketoff, American Coal Co.; Jos. F. White, White Fuel Corp.

Convention Chairman: Eben Lufkin, Lufkin Engineering & Equipment Co.

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Agree on 'Fair Employment' Setup in Shell Refinery

WASHINGTON—Shell Oil Co. and the Oil Workers International Union, Local 367 C.I.O. have agreed to adhere to a fair employment directive and eliminate from an existing bargaining agreement provisions that would limit promotional opportunities for Mexican and Negro workers at the company's Deer Park Refinery at Houston, Tex., it was announced this week by the president's Fair Employment Practice Committee.

All parties to the case—company, union, and FEPC—agreed that "definite steps" should be taken within 90 days, FEPC chairman Malcolm Ross said, adding that the settlement "stands as an excellent example of meeting the manpower shortage by utilizing the full skills of minority group workers."

After joint conferences of FEPC, the company and the union and a public hearing in Houston last month, immediate consideration for upgrading was requested for two Mexican workers who had filed complaints.

The decision directed that company's seniority chart — limiting Mexican and Negro employees to upgrading in jobs only to janitors and gardeners, while placing no such limitations on white workers—should be revised to eliminate references to "Negro and Mexican laborers" and "white yard men or laborers," and that the contract between company and union be modified.

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Ox-O-Gas Proprietor Given FTC Order To Desist

NPN News Bureau

WASHINGTON—The Federal Trade Commission this week ordered Eli Eghan, of Ox-O-Gas Co., Palisades Park, N. J., to stop "misrepresenting" the properties and efficiency of a gasoline additive he sells, named "Ox-O." Eghan also sells gasoline treated with the additive, FTC said.

Claims by Eghan that his products "are capable of increasing the combustion efficiency or power of an internal combustion engine or the mileage supplied by the engine, and will provide quicker starting or faster pickup" were disproved, according to FTC, by Bureau of Standards tests.

FTC's Order 5040 (gasoline additive) directs the respondent to stop making such claims in his advertising and to "cease representing that Ox-O has been approved by the major oil companies."

For Tank Truck, Loading Rack and Pipe Line Service

PITTSBURGH

ROTOCYCLE

METERS

No. 6 Rotocycle with welding end manifold. Any type of flanged fittings can be furnished as connections.

Put the "SURE" in MEASUREMENT

There's no chance for measurement error when Rotocycle Meters are on the job. Leaks, unauthorized withdrawals, inaccurately calibrated tank compartments, mistakes in gauge readings—all are caught and eliminated when these sure, positive, dependable measuring instruments are installed on your lines.

What's more, the design of the Rotocycle brings to positive displacement metering a new high in perfection; a ruggedness, combined with sustained hairline accuracy, that inspires confidence in the recorded totals by both buyer and seller alike.

There's no other meter like the Rotocycle. It's been thoroughly proven over a period of years on the most rigorous services in the petroleum industry. Investigate the Rotocycle when in the market for tank truck, bulk plant, or pipe line meters. You'll find that it sets the value and performance standard against which all others must be judged.

THE ROTOR

An Exclusive Design Feature

This positive displacement measuring mechanism consists of all-revolving parts, is free-running for minimum pressure absorption, yet sturdily constructed to resist wear and stand up under the most exacting service demands. Measurement is accurate over the entire flow range and under varying pressures, specific gravities and viscosities. The Rotor is assembled as a separate unit (as shown above) and is readily accessible without removing the meter from the line.

PITTSBURGH EQUITABLE METER CO.

Atlanta — **MERCO NORDSTROM VALVE CO.** — Boston
Chicago — Main Offices, PITTSBURGH, PA. — Houston
Kansas City Los Angeles New York Pittsburgh San Francisco Seattle Tulsa

National Meter Division, Brooklyn, N. Y.

PITTSBURGH-EMPIRE

MANUFACTURERS OF THE MOST COMPLETE LINE OF PETROLEUM METERS IN THE WORLD

Meters

REFINING NEWS and TECHNOLOGY

A.P.I. Lubrication Committee Maps Expanded Activities

NPN News Bureau

NEW YORK—Anticipating the post-war period, the lubrication committee of the American Petroleum Institute at a meeting here on Jan. 25, instituted plans for the reorganization of the committee and expansion of its activities to include technical problems.

Another meeting of this committee is scheduled here at 10 a.m. Feb. 20.

The objective of the reorganization, L. C. Welch, chairman, said, is to get the committee on a basis where it will function as a clearing house for the management and technical lubrication problems of the industry. Mr. Welch has asked for the help and co-operation of the representative technical men in the industry engaged in classification, recommendation and application of lubricants, to advise the committee on these various functions.

Plans call for the division of technical activities into two major groups: automotive and Diesel engine lubrication; industrial lubrication. Under the first group there will be sub-committees on motor oils and gear oils. The other group will deal with general purpose oils, circulating, hydraulic and turbine oils, gear oils, soluble and cutting oils, miscellaneous oils, petrolatums and waxes.

No sub-committees on greases for either the automotive or industrial groups are proposed, it being the hope and expectation that the National Lubricating Grease Institute will continue to function as at present. All technical problems involving greases will be referred to it, with the aid of a liaison representative for each of the two A.P.I. groups.

Crude Stocks Dip 336,000 Bbls.

NPN News Bureau

WASHINGTON—Domestic and foreign crude oil stocks for the week ended Jan. 27 totaled 221,310,000 bbls., down 336,000 bbls., from the revised total of 221,646,000 bbls. for the previous week, the Bureau of Mines announced.

Oil Industry Is Now Nation's Biggest Chemist, Dr. Wilson Tells Chicago Welcome Dinner

NPN News Bureau

CHICAGO — About 150 fellow chemists of the Chicago Chemists Club on Feb. 1 gave a "welcome home" dinner to Dr. Robert E. Wilson, who on Jan. 1 returned from a ten years' absence as head of Pan American Petroleum & Transport Co. in New York, to become the new board chairman of Standard Oil Co. of Indiana. Dr. Wilson is the first chemist to hold that position in the history of the company.

Speakers were R. R. Burtner, club president, and E. H. Volwiler, a member; Roger Adams, board chairman of the American Chemical Society, and Ward V. Evans of the society's Chicago section; W. S. James, president, Society of Automotive Engineers; R. B. Harper, Chicago section, American Institute of Chemical Engineers; Gustav Egloff, Chicago section, American Institute of Chemists, and George I. Haight, Chicago Patent Bar Assn.

Robert E. Wilson . . . finds tail now wags the dog

In responding, Dr. Wilson declared that the petroleum industry during the war had become a larger volume manufacturer of synthetic organic chemicals than the chemical industry itself. People are behind the parade, he said, when they talk about the petroleum industry getting into chemistry. Although in the prewar period synthetic chemicals derived from petroleum were a rather small tail on the chemical industry dog, today, he asserted, they have become so large that the tail wags the dog.

Cites Phenol and Aniline

Phenol, used as the base of many plastics, and aniline, largely used in dyes, were two examples of important synthetic organic chemicals cited by Dr. Wilson. Prewar production of phenol was only about 500 b/d and of aniline, about 300 b/d, he said. About 1550 b/d of toluene was also made from coal tar before the war, and now the synthetic product made from petroleum totals about five times the prewar volume of all three.

Still another vital synthetic chemical now coming from both the chemical and petroleum industry, is butadiene, which Dr. Wilson said is being produced at the rate of 8000 b/d, or 27 times the prewar production.

But these were called minor-league figures.

"I believe the largest volume product of the synthetic organic chemical industries is ethyl alcohol," he continued, "the wartime demand for which, in connection with the production of synthetic rubber alone, is about three times the total peacetime demand for all purposes."

Present demand is about 40,000 b/d, he said, more than half of it being made by fermentation of molasses and grains, rather than by what are ordinarily considered to be synthetic processes. But even this figure is dwarfed by the petroleum industry's current production of around 130,000 b/d of alkylate made from two simple hydrocarbons by a reaction whose existence was not even suspected a dozen years ago.

New Techniques Found

"This synthetic mixture of closely related hydrocarbons is the most important constituent of 100-octane gasoline," the speaker continued. "As a matter of fact," he said, "well over 300,000 b/d of 100 oct. gasoline constituents are synthetic hydrocarbons if we include the new types of molecules which are produced by isomerization and catalytic cracking.

"In entering this field, the industry not only went into catalytic operations on an unprecedented scale," he added, "but invented important new techniques which bid fair to revolutionize large scale catalytic operations.

"A catalyst is usually defined as a substance which speeds up a reaction without being consumed therein, but there is always some unavoidable loss, and in the case of catalytic cracking the average daily consumption of catalyst is in the neighborhood of 200 tons."

This consumption, Dr. Wilson said, probably exceeds the total consumption of all the catalysts of the entire chemical industry.

Manual on Valves Offered

NPN News Bureau

WASHINGTON—Copies of Simplified Practice Recommendation R205-44, Iron and Steel Relief Valves for Petroleum, Chemical and General Industrial Service, are now available from the Superintendent of Documents, Govt. Printing Office, Washington, at 5c each, the National Bureau of Standards has announced.

STA-VOL-ENE the "Natural" known throughout the World, partner of the automobile, helped give us the American-Way of Life—is doing more in helping preserve that freedom . . . with Peace will be ready for the highway, contributing much to the many new developments forecast for tomorrow.

Hanlon-Buchanan, Inc

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London, England

Hails Sales Engineer 'Man of the Hour'

Special to NPN

DETROIT—Speaking before the Engineering Society of Detroit meeting at Rackham Educational Memorial on Jan. 30, L. C. Welch, general manager of the lubricating and sales technical service department of Standard Oil of Indiana, focused attention upon the rapid developments in engineering and the engineering profession during the past decade and predicted that the specialized sales engineer would be the man of the hour in the early postwar period.

Sales engineering, he said, was an evolution of more traditional engineering activities of research, development, design, construction, production and operation. Besides the demonstrated ability to erect a plant and be instrumental in its initial operation, the engineer ought to know something about the products produced and thus qualify as a sales engineer, he asserted.

Outlines Plan

Forecasting a greatly increased demand for graduate engineers with technical and sales ability in the postwar period, Mr. Welch said that the prestige of men with engineering training would receive great impetus. He expects that many industrial concerns, in an effort rapidly to develop capable talent, will initiate, reinstate or extend training courses where selected graduate engineers, with and without sales experience, will receive intensified instruction.

Standard of Indiana has followed such a plan since 1924, he said, conducting schools at a laboratory at Standard's Whiting refinery, equipped with lecture and demonstration facilities, which also permits drafting of personnel from all departments for lectures and study of actual operations. Classes number about 30 and continue about five months.

"The cost of conducting these schools," Mr. Welch said, "including salaries of students, has approximated $75,000 each so that at the conclusion when the men actually enter our employ, we have an investment in each student of $2500 each.

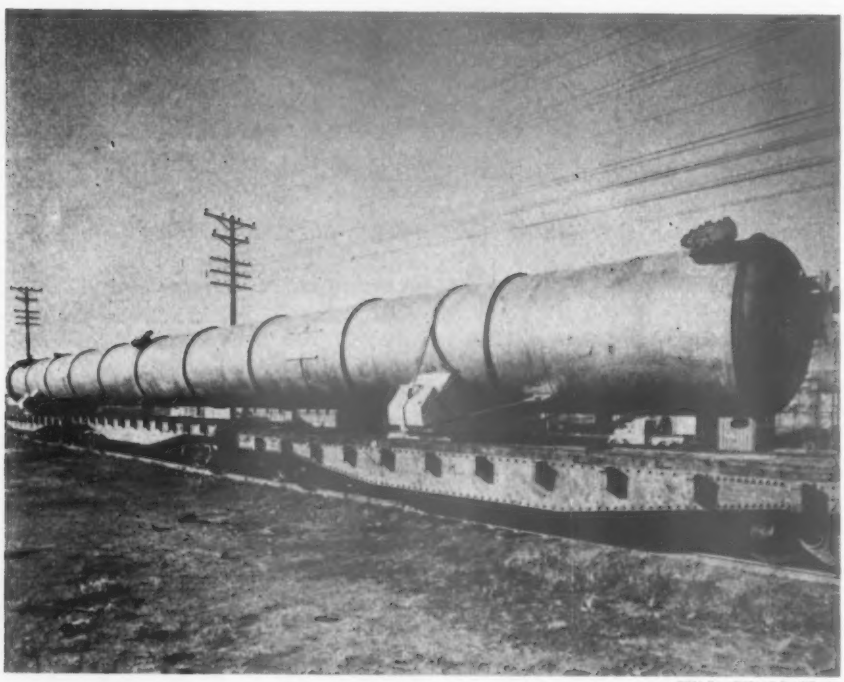
"We are firmly convinced that this is a very profitable investment. Many of our most capable sales engineers are graduates from these schools."

Many of these trained men are now on leave in military service, but with their return, it is anticipated that from 50% to 60% of the original enrollment over the past 20 year period will still be in the company's employ.

"In the new and improved model of the mechanical age that is surely ahead of us during the postwar period," Mr. Welch concluded, "there will be a greatly increased demand for: War developed, higher quality, higher performance products, for improved techniques and methods of application and for better educated, better trained personnel to explain and sell both.

"Where can we find the men necessary to meet these demands," he asked, "except among the well grounded, well qualified sales engineers, trained in basic engineering and in the merits of their company's line of products. The sales engineer will be the man of the hour."

Vapor Tower, Shipped by Rail, Covers 3 Flatcars



Wide World Photo

Soon to help increase the flow of petroleum products is this giant vapor tower shipped south by the Chicago & Eastern Illinois Railroad. The tank, is 124 ft. long and stretches across three flat cars. Extreme care in routing was necessary as clearances along the entire route of shipment had to be checked. The tank was mounted on special blocks which acted as swivels, allowing the cars flexibility in rounding curves

Doughton To Go To Paris For State Department

NPN News Bureau

WASHINGTON — Isaac Doughton, once with PAW here and more recently assistant Director of the Foreign Economic Administration's petroleum division, will leave for Paris shortly on temporary assignment as the State Department's special petroleum attache for Western Europe.

One of his main jobs while in France, it is understood, will concern oil supplies for civilian use. He may also discuss with military authorities the feasibility of early permission for American oil industry representatives to enter France so that they can take inventory on the present French oil situation and outlook.

For a number of years before the war, Mr. Doughton was a foreign representative of Atlantic Refining, stationed in Antwerp. He was loaned to PAW for a short period in 1942, transferring to the Board of Economic Warfare that same year. Early in 1944, he became an assistant director of FEA's petroleum division, in charge of European operations.

Shell Reports New Record For Bayou Pipelines

Special to NPN

HOUSTON, TEX. — Shell Pipe Line Corp. reports that for the month of January the Bayou Pipe Line System pumped a new record daily average throughput of refined products into Baton Rouge and Port Allen of 65,091 barrels.

When pumping gasoline alone, the 10-inch line averaged 67,921 barrels, while the 8-inch line into Port Neches averaged 44,015 barrels.

For the year 1944 the 10-inch line averaged 63,068 barrels despite several periods when it could not be supplied to full capacity.

The 8-inch line with full supply averaged 42,150 barrels for the year. The average handling loss for the year, including that in connected refiners' and terminals' tanks, was 0.12%.

Booklet on Aviation Gasoline Issued by Jersey Standard

NPN News Bureau

CLEVELAND—A booklet called *Aviation Gasoline* has been issued by the Standard Oil Co. of New Jersey.

Written almost entirely in non-technical language, both the nature of the aviation grades of gasoline and the methods by which they can be safely moved and stored is described. All the grades currently available except Grade 62, it notes, contain tetraethyl lead to give resistance to detonation or knocking.

TRUCK SERVICE MEN

who know what's expected of them—

New Trucks: The government has authorized the manufacture of a limited quantity of trucks for essential civilian hauling. International is building them in medium-duty and heavy-duty sizes. See your International Dealer or Branch for valuable help in making out application.

What's most important about truck service today?

Isn't it this: That the men who provide the service know what's expected of them . . . know that somehow they've got to keep overage trucks at work, hauling the million-and-one things a victory-bound nation needs?

Every day these men fix old trucks long overdue at the scrap heap—trucks that almost say, "I defy you to keep me hauling at a reasonable operating cost." The service men don't scare. Their attitude seems to be: "You can't bluff me, old timer, I'll keep you humping." And they do.

The service men at International Truck Branches, the nation's largest company-owned truck-service organization, and the service men who work for more than 5,000 International Truck Dealers aren't supermen. Sure, they have top tools, equipment and experience, and genuine International Parts. But they also know what's expected of them—know that unless they keep old trucks rolling, some of the things a victory-bound nation needs won't get there.

These men get no honors. They simply do what is needful—keep overage trucks at work when we'd all suffer seriously if the old trucks failed to perform.

INTERNATIONAL HARVESTER COMPANY
180 North Michigan Avenue
Chicago 1, Illinois

HARVESTER

INTERNATIONAL *Trucks*

Big and Little Inch Pipelines Given Praise in Congress

NPN News Bureau

WASHINGTON — PAW statement showing that oil deliveries to Dist. 1 by all methods of transportation averaged 1,712,129 b/d during 1944 was placed in the Congressional Record this week by Rep. Snyder of Pennsylvania.

Biggest contribution to the East Coast movement, PAW said, was by pipelines, which averaged 662,599 b/d. Tank cars averaged 646,113 b/d, ocean tankers 275,766 b/d and lake tankers, barges, and inland waterway operations, 127,641 b/d.

In presenting the PAW statement, which dealt largely with operations of the Big and Little Inch pipelines Rep. Snyder told the House that the two projects "will go down in this war effort as one of the outstanding major accomplishments, not only with reference to time building, but results."

Whitman, 30-Year Oil Vet, Joins PAW Headquarters

WASHINGTON—Latest addition to the PAW headquarters staff, as an assistant director of supply and transportation, is Clayton H. Whitman, a veteran of 30 years in the oil business.

He succeeds Bruce Clardy, who left Jan. 1 to get back into drilling and production operations in Texas. As assistant director, Mr. Whitman will be in charge of pipeline engineering and construction activities, pipeline operations and crude supply.

The new assistant comes to PAW from Jersey Standard, whose crude purchasing department in Shreveport he has been managing since 1937. Before that, from 1915 to 1926, he was in the yield and cost department of Louisiana Standard at Baton Rouge, and from the latter year until 1937 he was assistant to the head of Jersey Standard's Co-ordination department in New York City.

Mr. Whitman is a native of Louisiana.

Gas Line Nears Completion

NPN News Bureau

LOS ANGELES—Costing $4,000,000, the 105-mile natural gas pipeline from the La Goleta dry gas field to Los Angeles was nearing completion this week.

S.A.E. Maintenance Men Told Immersion Heaters And Infra Red Lamps Aid Quick Starting

NPN News Bureau

NEW YORK—Use of electric immersion heaters in engine water jackets, better care of batteries, and installations of infra red "parking" baths to keep vehicle engines warm when parked out of doors, were among the recommendations made here on Feb. 1 at the transportation and maintenance meeting of the Metropolitan Section, Society of Automotive Engineers.

Emil P. Gohn, newly elected vice-president of the society; H. C. Riggs, of the Electric Storage Battery Co. and Robert H. Dalgleish, of the Philadelphia Transportation Co., suggested these ideas to fellow transportation engineers at a symposium under the direction of T. A. Drescher, transportation head of the Borden Co., New York.

An Idea for Postwar

Mr. Gohn, automotive engineer of the Atlantic Refining Co. of Philadelphia, recounted the results of experiments with commercial vehicles which he said showed that application of immersion heaters reduces engine starting time to seconds and appears to raise the temperature of crankcase oil, bearings and parts to a degree which assures quicker warm-up, better lubrication, and reduced maintenance costs.

"This quicker starting method," Mr. Gohn said, "merits postwar thinking, and engines should be designed for heater installations to take advantage of what appears to be relatively simple and economical means of quick-starting the engines of automotive equipment stored outdoors or in unheated garages."

"Two electric immersion heaters with total 1250-watt capacity raised block temperatures to 44 deg. F., making 20-second starts possible in zero weather."

Mr. Gohn said that when block temperatures were increased to 53-54 degrees, starting time was reduced to 6.5 seconds. He indicated that in temperatures of 17 degrees below zero, it is possible to start engines if jacket temperatures are raised to around 57 degrees and warm, fully-charged batteries are used.

He reported that minor differences in water jacket temperatures have major effects on starting ease. At zero, heating the liquid in the water jacket to 44 degrees produced an easy start in 21 seconds. If the jacket liquid was heated only to 36 degrees, however, starting required about three times as long.

Mr. Riggs said that while a battery is frequently chosen only according to its ampere-hours capacity, other factors should also be considered, since different kinds of internal construction give different discharge characteristics.

Thus, if a long cranking time is desired at 0 degree F., a certain battery may be the proper one, but if the particular engine requires a high minimum cranking speed for firing, another battery giving this speed may be necessary.

The Philadelphia Transportation Co., which was unable to build additional garage storing space because of war restrictions, solved the problem of storing its busses outdoors in cold weather by a novel application of infra red heating, Mr. Dalgleish said.

Pits, measuring 27x42x16 inches, were dug in the parking lot, and so spaced as to allow buses to be parked with the engine over the pit. The pits were each fitted with four infra red lamps and protected with a heavy wire screen. The only alternative would have been to keep the engines idling when not in use to prevent freeze ups and permit easy starting. This, Mr. Dalgleish said, would have involved an excess cost and would have required many gallons of gasoline.

The infra red pits cost about $107 each and the cost of electric power for the lamps was only 28 cents per bus per day.

China Pipeline Tough Going, Writes Col. Kinsolving

NPN News Bureau

WASHINGTON — The going on the Army's Burma-to-China pipeline is tough but the American pipeliners building it are equally so.

That's the word received here from Col. W. C. Kinsolving, ex-PAW Assistant Transportation Director and, in days of peace, general manager of the Sun Pipeline Co. He is now one of the two U. S. pipeline experts immediately responsible for construction of the two main sections of the line to China.

Writing from Calcutta, India, to Ludwig (Curley) Caminita, Jr., assistant director of PAW Public Relations, "Colonel Bill" tells something of the job he's doing in the following words:

"As you might well expect I am up to my eyebrows in pipelines and still going strong. Have now passed the Big Inch record for mileage and boy what miles they have been. The going is tough but so are my pipeliners and it will make a good story when the war is over.

"Wish I had the old PAW publicity staff and colored movies. I'd go on a lecture tour that would lay 'em in the aisles."

Norway Lent Two More Tankers

WASHINGTON—Allocation of two additional T-2 tankers to the Norwegian government has been approved by WSA, it was announced today, making eight tankers of this type designated by WSA for operation under Norwegian flag and registry.

NATIONAL FOAM FIRE PROTECTION

Official U. S. Navy Photograph

When Foam Extinguishes Fire There Are No Flashbacks

Foam is the acknowledged medium for extinguishing fires in oil, gasoline and other petroleum products, also other serious industrial fires. It is the only means of providing a tough, lasting blanket which stays on the surface to prevent flashbacks and is not readily *dissipated by wind or draft.*

Our Engineers will be glad to consult with you and recommend the type of Foam and equipment best suited to your needs.

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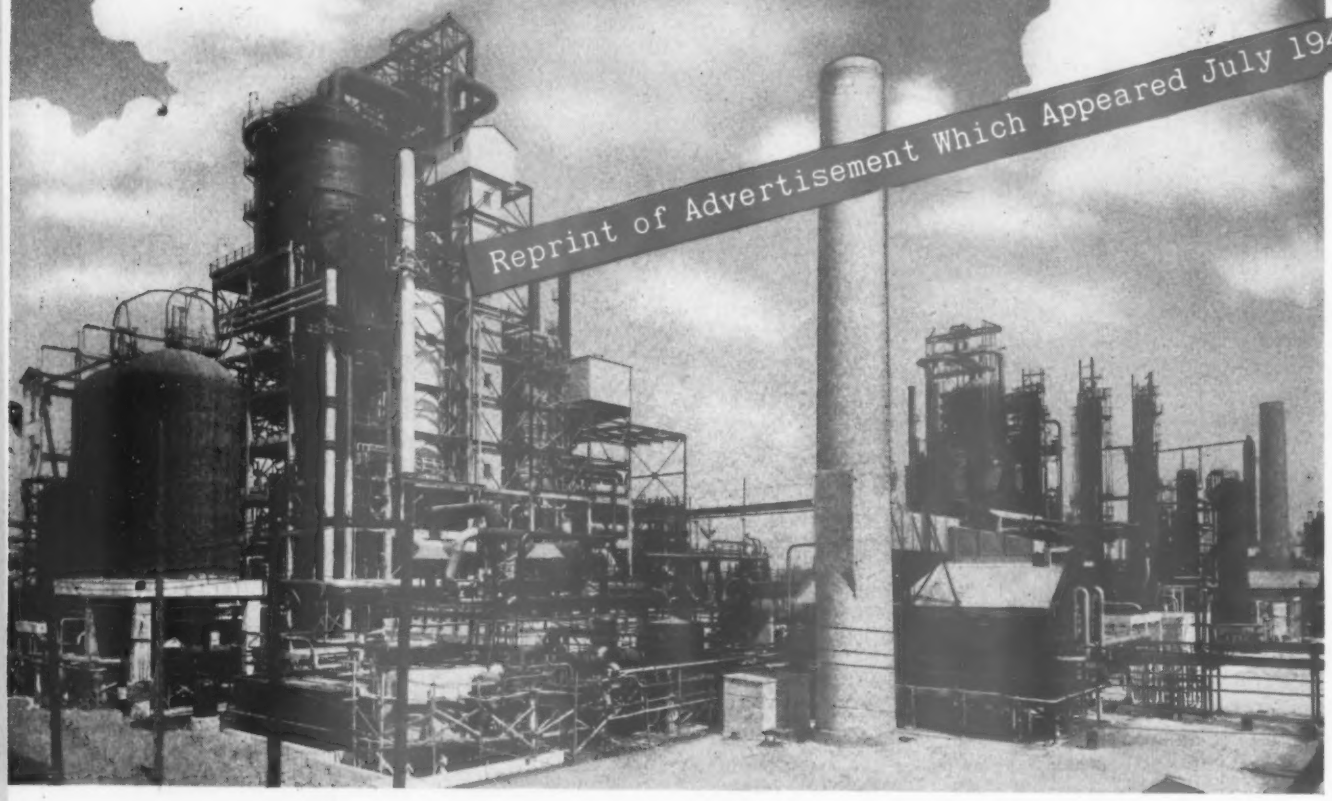

QUESTION 1: **What process now leads in production of the nation's high-octane gasoline requirements?**

ANSWER:

Current figures show that when *all* catalytic-cracking fresh feed capacity is considered – including pre-war fixed-bed catalyst processes – the *Fluid* "Cat-Cracking" process now comprises over 50% of the industry's capacity! Further, the ratio of *Fluid* "Cat-Cracking" capacity to that of the nearest competing process is over *two-to-one!*

QUESTION 2: **Why are leading refiners sold on this process?**

ANSWERS:

1. When built, *Fluid* "Cat-Cracking" plants operate as designed. Production meets specifications. War commitments are realized with efficiency to spare.

2. High efficiency is maintained under a wide variety of operating conditions. For instance, the severity of cracking effected by the ratio of catalyst to charge in the reactor can be varied as much as *twentyfold!* This unmatched flexibility characteristic of the *Fluid* "Cat-Cracking" process permits production today of the all-important high-octane and butadiene components from different types of feeds ... ranging from reduced crude to naphtha. Even high sulphur-bearing feed stocks can be proc-

essed by incorporation of a moderate amount of corrosion-resistant materials in the reactor. *Tomorrow*... this flexibility will permit use of the most economical of feeds to produce premium postwar products.

3. Control of product quality is simplicity itself. Due to the fluid properties of the catalyst... its flow responds to recognized principles. Operating conditions for any run can be quickly established and maintained with little, if any, adjustment of a few simple controls.

4. The flow principle of the catalyst system requires no moving mechanical parts, thus assuring a high service factor. On-stream runs of 4 to 6 months have been reported to date. In addition to this saving in operating time... conventional maintenance costs are reduced to a minimum.

Small additions of catalyst which are easily and regularly injected into the system maintain the catalyst at high efficiency. Manpower costs for operation and maintenance are also minimized.

QUESTION 3: What has M. W. Kellogg contributed to catalytic-cracking?

ANSWER:

On the record... *over two-thirds* of the *Fluid* "Cat-Cracking" capacity built since Pearl Harbor—and now in operation—has been built by The M. W. Kellogg Company. Our laboratory helped develop the *Fluid* technique... our engineers translated it into commercial reality. Today, our continuous pilot-plant operation provides the accurate data necessary to evaluate feed stocks and to evolve process designs for specific applications.

CONCLUSION

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future?..the *Fluid* "Ca
overwhelming choice
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Transporters Rebuffed By ICC Predict Hard Postwar Fight

NPN News Bureau

CHICAGO — Future keen competition in the petroleum transport business and between transporters and the railroads broke out into the open in the past few days when the Interstate Commerce Commission declined to approve applications for permanent permits of Indianhead Truck Lines of Minneapolis and the Home Oil & Gas Corp. of St. Joseph, Mo., to operate in certain areas.

Indianhead operated only dry cargo trucks prior to the war, and the Home company acquired permits from its predecessor, the Home Oil & Supply Co. of Grant City, Mo., in June of 1943.

According to Jack Zurow, head of the Home company, some of the company's permits were issued prewar and are permanent, covering Coffeyville, Kan. area pickup points for deliveries to northwestern Missouri. The temporary permits cover Kansas City, or Fairfax district, pickup points, and these are the ones it is desired to make permanent.

In having a look at the transportation picture, it seems that when tank cars were withdrawn from the Midwest and put into eastern service, there was something of a gentlemen's agreement between the railroads, the Interstate Commerce Commission and at least some large transporters that only temporary permits would be issued for wartime truck routes and that the matter would rest there until the present emergency is past.

Transporters Jump Gun

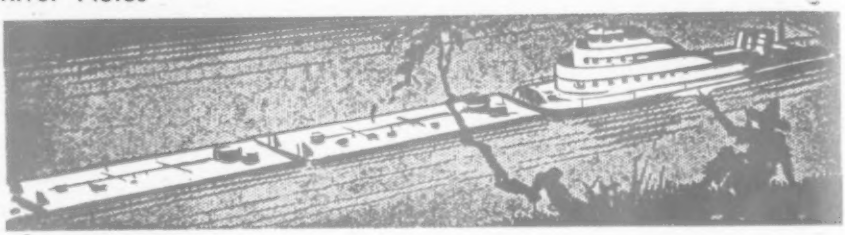
Various circumstances have caused some transporters to jump the gun. A large Midwest transporter with headquarters in Chicago, as an example, asserts that a competitor in St. Louis obtained temporary permits to operate over routes they had given up due to the curtailment and wearing out of equipment. Last summer, the St. Louis transporter applied for and was issued permanent permits for those routes.

Since then a number of other applications for permanent authority have been filed with ICC. Some of the operators say they were not aware of any gentlemen's agreement to let the matter wait until after the war and simply filed their application to get on a permanent basis as a matter of looking ahead. They see no reason for being forced to discontinue operations at the war's end after having rendered a valuable service through the emergency of three or four years. Principal opposition, of course, comes from the railroads, who point out that they also have rendered a valuable service through the same period and that their equipment was ordered away from peacetime routes by a government agency, ODT.

However, a good many other things enter into the story when it is looked at in detail. For instance, the railroads have abandoned numerous unprofitable short lines and left oil jobbers and their retail outlets stranded for petroleum supplies, which they can now obtain only by transport truck. That is the case with some delivery points of Home Oil & Gas Corp. in Northwestern Missouri, according to Mr. Zurow, who points out that although he has other transport competition in the area, the railroads were the only ones to appear in opposition to his application for permanent authority.

Perhaps one of the strongest ties the railroads have upon the petroleum shipping business stems from the fact that by far the majority of bulk plants in the Middle West and throughout the country are on railroad property, and in most cases the railroads gave the bulk plant operators location leases at "very fair" annual rental in order to obtain the freight, which even with average size jobbers may run from $10,000 to $20,000 yearly. So the railroads lost nothing by granting inexpensive ground rentals—but it would cost the oil industry many thousands of extra dollars to relocate bulk plants if they employed truck transportation and were forced off railroad property.

River Notes—



By David I. Day

Movement of oil on the Mississippi from the St. Louis area southward appears to have been intensified somewhat since the holidays despite high river, swift currents, and floating ice in the vicinity of the Missouri metropolis. Recently for example, the good steamer "I. A. O'Shaughnessy" of the Globe Oil Barge Co. brought up from Memphis to Wood River, Ill., some 6000 tons in seven days. The trip from Wood River down to Memphis consumed a little short of three days.

About the same time, the DPC steamer "Gona" under charter to Globe Oil completed a 17-day round trip between Wood River and Destrehan, La., bringing up approximately 11,000 tons of oil. This boat, we understand, has since been shifted to the fuel oil trade between Gale, Ill., and Destrehan. On the same journey, we saw the "Robert P. Gipson" as well as the "Ellen" and others of the smaller towboats in the oil business working smoothly near St. Louis.

In that city and in Alton, oil rivermen expressed gratification that the Coast Guard will have permanent all-weather buoys installed the length of the Illinois. It will be the first time this stream of growing navigation importance could boast of a marked all-season channel all the way.

° ° °

We found plenty of river news on the lower Ohio. There was still talk of the passing of the only river tanker, the "Republic-Pittsburgh" which has been for months at the Hillman shipyards at Brownsville, Pa., being completely remodeled and given increased power to about 1620 h.p. It is understood she is in the oil moving trade under charter to the American Barge Line under command of the popular Capt. H. L. Morse.

It was reported at Paducah that the big 14,000-ton oil tow being pushed up the Ohio by the steamer "Tennessee' of the Mississippi Valley Barge Line was in charge of Capt. A. J. Trosclair, with Capt. John B. Ritchie as pilot, and Carl E. Berry as chief engineer, Murrel Miller serving as mate. Since this steamer and her companion boat the "Indiana" were up the Ohio late last year, she has become a popular favorite with all the upper river boat fans.

° ° °

Above Cincinnati, two topics of interest appeared at all ports. One was the fact that the Standard Oil of Ohio was ready to increase the storage capacity at its Clarington, Ohio, river terminal and in that connection much favorable comment was made concerning this winter's work of the game old towboat "Sohio" under command of Capt. O. A. Stacy. It may be recalled we described this little towboat and her history in this column some months ago. We observed her recently headed up against rather rapid current pushing three barges of gasoline.

Another matter of general interest was the trip up of that perennial favorite, the "Celeste" which we featured in our report not long ago while she was anchored at Pittsburgh. It was stated at two or three stops that on one of her recent trips up with six heavily-loaded barges, she really showed her power and maneuverability under heavy pressure of wind and water. All the oil boats seemed very active, considering intense winter weather, as we saw at work old favorites like the "Margaret Dawson," the "Henry C. Ogram," the "Miss Sterling," the "Dan Quinn," the "Reliance" and the "Williemayo"—with some we could not identify in the fog.

High water, strong current, rain, and fog have all made river transportation difficult and somewhat dangerous. Several boats in the oil trade all or a good portion of the time experienced considerable difficulties recently at various points. In a few instances, disaster was averted by the narrowest of margins.

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Reports Oil Gain by Flooding Limestone in Illinois

NPN News Bureau

CHICAGO—Data on one of the relatively few secondary-recovery projects in limestone reservoirs has just been released in a report by the Bureau of Mines, according to an announcement received here. The report was prepared by C. H. Riggs, associate petroleum engineer, and shows an 87,000-bbl. increase in oil production in 20 months for 41 oil wells in the Clay City field in Clay County, Illinois.

The project is on a 13,000-acre tract in the McClosky limestone, and the results were obtained by injecting 1,900,000 bbls. of river water into three old wells along the edge of the field, the report shows. It was the first attempt at water flooding a limestone formation in this state, and one of the few in the nation, said Dr. R. R. Sayers, director of the Bureau, when releasing the report.

A discussion of the development, production and reservoir conditions in the Clay City field is included in the report, which also shows the estimated oil drained from each well affected by water injection. Additional details are given on the elapsed time between the start of water injection and the first increase of oil. A copy of the report may be had by writing the Bureau of Mines, Department of the Interior, Washington 25, D. C., and asking for Report of Investigations 3792, "Water-Flooding of the McClosky Limestone in Clay City Oil Field, Clay County, Ill."

Humble and Associates Win Texas Oil Land Title

Special to NPN

WACO, Tex.—Humble Oil & Refining Co. and other associated oil companies have won their court case over title to 495.22 acres of Montgomery County oil lands.

The 10th Court of Civil Appeals upheld the decision of the Montgomery County Court, which had been appealed by the state of Texas and 17 groups claiming to be heirs of Wilson Strickland, whose patent title went back 90 years.

The opinion written by Associate Justice Jake Tirey held that the original title was good, that the state then lost title and that a claim of misconduct by the jury was not justified.

Nazis' Oil Plight; a British View—

Austrian Fields, Germans' Last Stronghold of Petroleum, Now Threatened by Soviet Drive

(Reprinted from The Petroleum Times, London)

As the headlines and radios tell of hourly advances by the Russians toward Berlin, and of the Nazis' desperate plans to carry on the fight from interior Germany and Austria, this story of the threat to Germany's last petroleum stronghold will be of particular interest. It is reprinted from the *Petroleum Times*, London.

With the battle-cry "On to Vienna," the armies of the Soviet Marshals Tolbukhin and Malinovsky are driving along the Central European road to the Reich.

As they sweep on, some Red Army units are less than 100 miles from Vienna and it is only natural that their drive towards the Austrian frontier in general, and in particular to the Danube city of Vienna, as the gateway to Germany proper and one of the most vital industrial centers of the Continent, has once more drawn world attention to Austria's situation.

Indeed, besides being an important center of the oil-refining industry, Vienna also gives easy access to the Zistersdorf oilfield, some 30 miles north of the capital, which in recent years has swiftly developed into the most productive crude oil source inside the "Fortress of Germany." It is perfectly true that Germany still possesses some other productive oilfields, even on her own soil, like those of Nienhagen, Oberg and Wietze, in the Province of Hanover, and that of Reitbrook, south of Hamburg, but even their aggregate output is now smaller than that of the Austrian oilfields.

Moreover, the distance from Venlo, on the Dutch frontier, the nearest point reached by the Allied forces in the West to Hanover is little less than 200 miles in a direct line—almost twice as much as the Red Army is from Zistersdorf. Little wonder, therefore, that the German leadership has taken all possible measures for the protection of Austria's eastern frontier and especially of the Danube gap forming one of the soft spots of the Reich defenses. Bearing these conditions in mind, it is evident that the Austrian oil deposits have gained a topicality as never before.

Now Principal Oil Source

Austria's fate as an oil-producing country is, in fact, without parallel. For a considerable period during the early part of this century Austria was the main mineral oil supplier of the European Continent. Then followed some 16 years during which no petroleum at all was obtained from Austrian subsoil.

In the third stage beginning in 1935, Austria again entered the list of oil producers, output rising rapidly in the following years, and becoming eventually the principal source of natural oil within the present German orbit. In fact, as early as in 1902, Austria's annual crude production—all from the Galician fields at that time—exceeded the 500,000-ton mark, reaching the peak volume of some 2,000,000 tons p. a. in 1909. Even in 1918, when Galicia became part of the Polish Republic, production from those fields was still as high as 600,000 tons. . . .

Today, the area of the Austrian capital has, in addition to its importance as an industrial and great communication center throughout the centuries, gained further importance for Germany through that alluvial region created by the Danube river round Vienna called the Vienna Basin.

It covers an area of some 2000 square miles, and in its northern sector, near the town of Drosing, on the Vienna-Lundenburg railway line leading to Prague and Warsaw, the small towns of Zistersdorf and Gosting are situated. It was

Texans Take Tip From War In New Perforating Gun

SAN ANGELO, Texas—Taking a tip from war explosives, a group of Texas men report that they now have an oil well perforating gun that will be a vast improvement over present methods.

The new gun operates like a cannon, shooting an explosive shell through the casing into the formation. The shell penetrates some distance into the formation after which it is exploded by a delayed action fuse, breaking up the stratum for scores of feet in all directions, the inventors say. Multiple shots may be fired at the same time.

Heretofore perforating guns have fired .45 caliber solid pellets through the casing.

Developer and patenter of the device is James Lewis Foster of Wichita Falls, now in the army overseas. The incorporators of Well Explosives, Inc., are A. J. Armstrong, R. C. Armstrong, W. H. Thompson, all of Fort Worth, and P. G. (Pat) Malone of San Angelo.

The Fort Worth men are officers and directors of the Texas Steel Co. and the Texas Steel Manufacturing Co., now making military shells.

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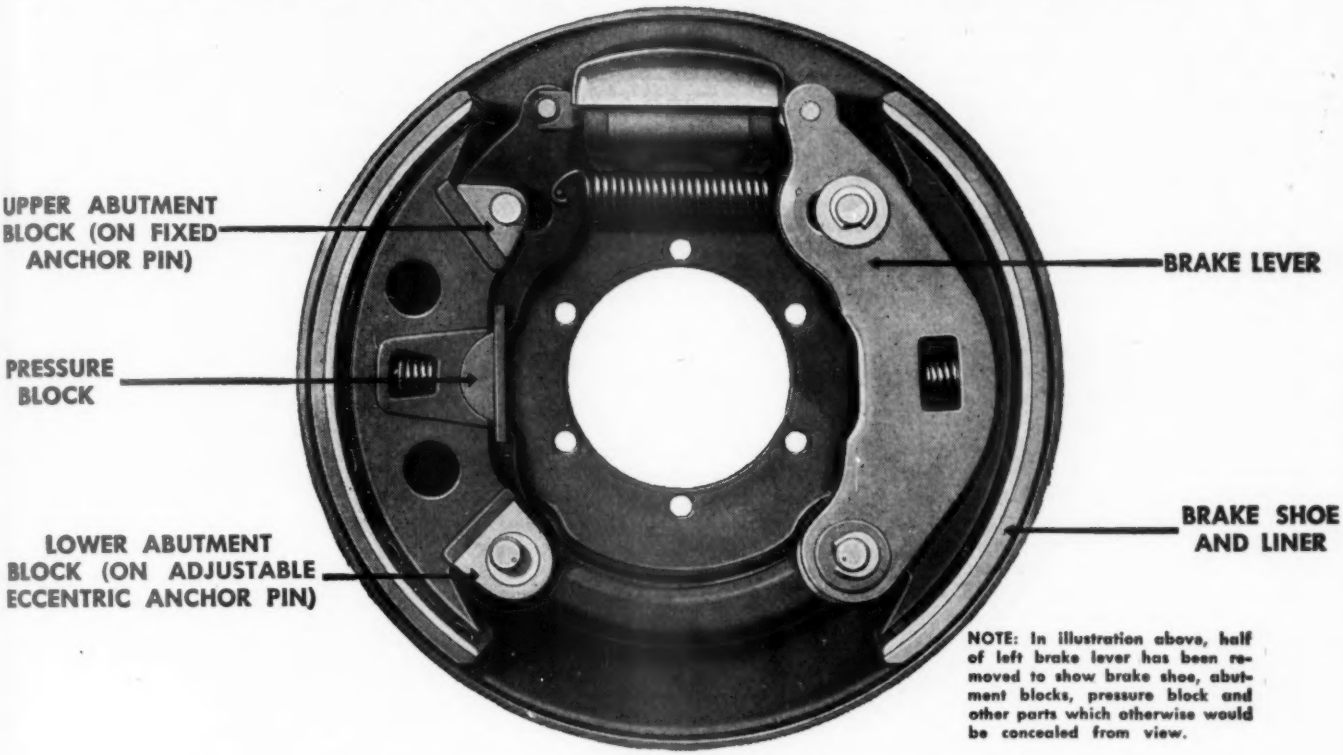
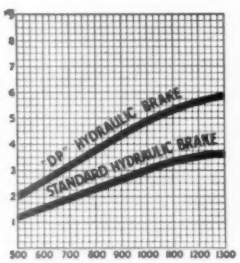
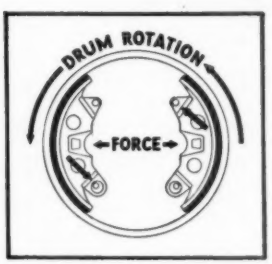
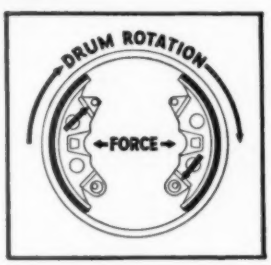

UPPER ABUTMENT BLOCK (ON FIXED ANCHOR PIN)
PRESSURE BLOCK
LOWER ABUTMENT BLOCK (ON ADJUSTABLE ECCENTRIC ANCHOR PIN)
BRAKE LEVER
BRAKE SHOE AND LINER

NOTE: In illustration above, half of left brake lever has been removed to show brake shoe, abutment blocks, pressure block and other parts which otherwise would be concealed from view.

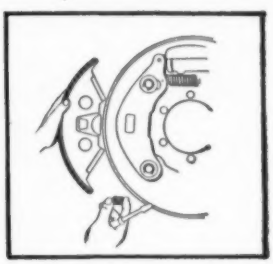


30% to 35% greater braking ability at all hydraulic line pressures.





Both shoes are equally self-energizing, regardless of direction of drum rotation.



Shoes can be removed in a few seconds, with just a screwdriver.

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there that for some years the existence of substantial oil deposits was suggested by experts.

There were no surface indications nor gas seepages. Geologists based their views on purely scientific considerations, derived from the formations of the strata and from the fact that the Vienna Basin was originally created by a large sinking movement started in the mid-Miocene and stretching into the mid-Pliocene age, the basin thus created being gradually filled up again by young Tertiary deposits.

Support for the view that the Vienna Basin should contain oil-bearing strata in the Zistersdorf area was not only provided by analogous formations in other countries being oil-containing, but also by the example nearer home that for some time a small production of heavy crude had been found in the Gbel and Hodonin areas in Czechoslovakia, albeit only some 4600 tons per year.

In spite of the poverty of Austria's natural wealth, the Government was deaf to the appeals of geologists for test wells to be sunk with state help. Everything had therefore to be based on private initiative, and it is to the credit of a small group of Austrians, foremost among them being geologist Dr. Karl Friedl, who, undeterred by innumerable refusals, interested foreign capital in the initial exploration of the Steinberg oil dome near Gosting. A few wells were drilled there and more at Zistersdorf.

The first production was obtained in 1930, but it was very small. The first commercial success was secured when early in 1935 the small drilling companies, Raky-Danubia and Erdolproduktions-Gesellschaft reached a daily yield of 20 tons. At that time, attention was rather directed to the exploitation of the natural gas deposits near Oberlaa, southeast of Vienna, where the Standard Oil (N.J.) owned European Gas and Electric Co. had already in 1934 reached a daily yield of 15 millions cu. m.

With a total population of 6-8 millions, largely engaged in agriculture, Austria's annual petroleum consumption of about 350,000 tons was small compared with that of some other countries of the same size. But even so, the Zistersdorf-Gosting output was far too limited to cover any appreciable proportion of total demand. Moreover, the quality of the Zistersdorf crude was rather poor, bearing in mind that the domestic demand for petrol greatly exceeded that of any other product.

Most of the crude oil is heavy and viscous, of a specific gravity of 0.940 (19.0 degrees A. P. I.); it does not contain any petrol and only a few per cent of kerosine, its main derivatives being gas oil, lubricating oils and asphalt. Another type of crude from the same region, of a specific gravity of about 0.900 (26.0 degrees A. P. I.) is paraffin-base, with an average yield of 3 per cent petrol, 28 per cent kerosine, and 21 per cent gas oil.

Although by the time of the occupation of Austria by the Germans 12 different oil horizons had been proved in the region, there was little deviation in the types of crude, the highest petrol content being only 8 per cent.

Other Areas Explored

Naturally the search for crude oil in Austria was not confined to the Vienna Basin or Zistersdorf area alone, but extended over wide parts of the country. Though some time before the Anschluss reports were received of discoveries in other regions, e.g., in the region of the Ybbs river in southwestern Lower Austria, no reliable information as to commercial exploitation has come to hand.

Austria also had a small shale oil industry established for some considerable time in the vicinity of Kufstein in the northeastern corner of the Tyrol. According to latest pre-war figures, production was little more than 300 tons p. a. As to natural gas, the situation was somewhat different, this having been found and exploited also in regions rather distant from Oberlaa, like Schwechat or the Wels Heath in Upper Austria.

Although in absolute figures, the development of Zistersdorf oil production was not really striking during the time before Hitler's march into Austria, in terms of relative expansion, it was most promising. While in the early stage of operations, apart from the already named Raky-Danubia and Erdolproduktions companies (the latter mainly working with Swiss capital), the Steinberg Nafta A. G. and the British-financed Britol Oel A. G.—drilling at St. Ullrich, near Neusiedl-on-Zaya, a few miles from Zistersdorf—were the only notable drilling enterprises.

As yields grew the necessity for erecting a cracking plant became imperative, and the daily capacity for the first installation of its kind in Austria was fixed at 2-300 tons. At that time the two largest oil companies in Austria, the Vacuum Oil Co. A. G. which, contrary to their policy in many other countries, was actively engaged also in the petrol and kerosine business, and the Shell-Floridsdorfer Mineralolfabriks A. G. stepped into the drilling sphere by the formation jointly in October, 1935, of the Roholgewinnungs A. G. (Crude Oil Exploitation Co.) with a share capital of 3,000,000 Austrian schillings (approximately 113,000 pounds) owned by them on a 50-50 basis. That crude oil production evidently benefitted from this influx of foreign capital can be held from the following details:

Year	Metres drilled	Production in m. tons
1928	13	..
1929	565	..
1930	740	5
1931	591	..
1932	303	73
1933	759	804
1934	166	4,124
1935	3,133	6,658
1936	4,954	7,473
1937	8,000	(app.) 33,000

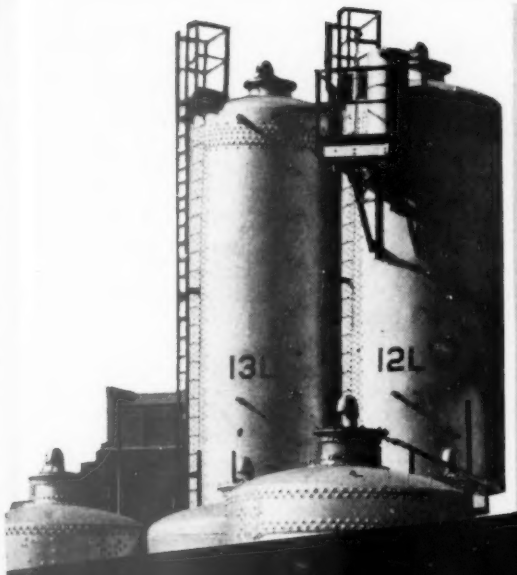
It is only when the situation outlined above is borne in mind and particularly the great difficulties connected with the opening up of any new oilfield, that it can be fully realized that practically all the pioneer work had been carried out before the arrival of the German invaders in Austria.

Forecast Big Production

Only by having a detailed and proper insight into the genesis and history of the Austrian oil drilling struggle can one properly appreciate who had to bear the brunt of the battle for oil, and whose is the merit if Germany was able to reap the benefits so soon after her taking charge of Austrian affairs, by increasing appreciably the production figures of the Zistersdorf oilfields.

The prospects for this speedy development were definitely favourable even before Germany took a hand in the matter, and in 1937, the year preceding the annexation of Austria, Dr. Karl Friedl could faithfully write in the Vienna jour-

Map shows location of Austrian oilfields



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nal *Petroleum*: "We thus can look forward with perfect calm and great optimism to the further opening up and development of the Zistersdorf oilfield. We can say that oil deposits are concerned of a magnitude of several million tons, and that the Zistersdorf oilfield has therefore certainly to be counted among the largest oilfields of Central Europe hitherto brought into exploitation."

His view was later more than confirmed by facts.

Development Under German Aegis

Right from their entry into Austria in March, 1938, the Germans lost no time in their efforts to increase the crude oil output. Teams of experienced German geologists and oil technicians, together with drilling experts from foreign oilfields, were drafted to the Vienna Basin.

New equipment was installed, new plants established and existing refineries enlarged and modernized, but at the same time a veil, thickening as time went on, was dropped over Austrian oil production, in secret preparation for war. Since Austria had been included in Goering's well-known economic Four-Year Plan, data on the results and location of new wells sunk was no longer published officially, though it is known that a few months after the Anschluss promising oil deposits were struck at a distance of six miles from the original well sites in the Zistersdorf area, thereby considerably extending it in length.

German oil concerns partly took over from former ownership, among them the Deutsche Erdol and Wintershall groups ranking foremost. Owing to the German policy of secrecy imposed, there is not even a reliable production figure for 1938. Information varies but most probably 57,000 tons were gained in that year, though another source puts production at 73,000 tons.

With the beginning of the war reliable information became still more scanty though it is understood that more than 125,000 tons of crude oil were obtained in 1939, the last official figure being for the month of July with 12,691 tons.

In the same month the total crude oil basis Austria supplied less than 20%. However, even so the rise was remarkable as in January of the same year the Austrian share had not even reached 10%. In 1940 at least 250,000 tons were produced, and the process of doubling the previous year's output was maintained in 1941. It was in this period that Austria for the first time supplied over 50% of Greater Germany's petroleum production.

From now on the tables were turned. Instead of the oil regions of Northwest Germany the oilfields of Austria became the center of Germany's supplies of natural oil from her "own" soil. Of course at that time the importance of Austrian oil had not reached the degree of extremity for Germany as is the case today, as then the Germans could safely reckon on the arrival of crude oil and finished products from both Roumania and Hungary; and were they not about to grasp the oil of the Caucasus?

Nevertheless the utmost efforts continued to enhance Austrian output and according to private information, which puts the 1942 yield at some 750,000 tons, results were better than ever. A new record was achieved in 1943, for various reliable sources agree than the 1,000,000-ton mark was exceeded for the first time.

Great Asset For German War Machine

Whether this swift development into one of the principal assets in Hitler's oil supply scheme still comes only from the Zistersdorf region or whether other regions contributed to it, is naturally unknown. Reports state that test wells have been sunk at different places of the Vienna Basin as well as in many other areas of Austria, including the Province of Styria. There is no doubt that by an increase of cracking plants and by the application of modern refining processes the yield of light products has been markedly increased over the poor results obtained in the earlier years, but it would appear that gas and Diesel oils on one hand, and lubricating oils on the other, have formed the main finished products secured. But these have been highly welcome for the German war machine. Indeed, as explained in these columns of *The Petroleum Times* (Dec. 9th, 1944), some 40% of German lubricating oil needs may have been supplied by Austria, especially as it can safely be anticipated that 1944 production has been substantially higher than that of the previous year.

Shell Refinery Biggest

What the loss or even the paralyzation of Zistersdorf would mean for Germany at a time when her synthetic oil production has been reduced to a mere fraction needs no emphasis. As to any synthetic plants in Austria, a country fairly rich in lignite but poor in coal deposits, while none existed before the war it is understood that several—the main one being at Moosbierbaum, 30 miles west of Vienna—have been in operation for some time now but little has been revealed as to their location and capacity. At least Moosbierbaum has suffered badly from Allied bombing.

For a long time before the Germans seized Austria that country had, however, large installations for refining such petroleum as was imported in the form of crude oil or as mixtures of semi-finished products. They were all concentrated in the region of Vienna, the biggest of them having been the Shell refinery in the Floridsdorf district of the capital, the Kagran refinery of the Vacuum Oil Co. in the same district, the more recently built plant at Korneuburg (just opposite Vienna across the Danube) which was operated by the Credit Minier Company, and the new refinery of the Nova A. G. at Schwechat, a few miles southeast of Vienna, controlled by French interests and finished not long before the war. A smaller plant was that of the Fanto Mineral Oil A. G. at Vosendorf, in Vienna's southern outskirts. For some years past the bulk of these plants has now been used for the treatment of Austrian oil, and there is good ground for the belief that part of the Zistersdorf crude output had even to be refined in various Czechoslovakian refineries.

All the enterprises just named, in addition to some companies solely engaged in marketing, had large storage installations on the right bank of the Danube in the Winter Harbour of Vienna. There, also, were the important storage installations of the Donau Oeltank Company, used jointly by several companies. This concentration of most of Austria's tank capacity within the orbit of Vienna was due to the fact that the country had no other sizeable Danube harbour, that of Linz in Upper Austria becoming important only after its enlargement by Germans.

Achilles Heel of German Oil

After the Anschluss most of the Austrian oil companies changed hands, being taken over by their German counterparts, like the Rhenania Ossag for the "Shell" or the Deutsch-Amerikanische Petroleum A. G. and the Deutsche Vacuum Oel A. G. for the Standard-Vacuum interests, or taken over by purely German interests like Wintershall or the Benzol-Verband, and as was the case in numerous other countries under German domination Kontinentale Oel Company gradually made its influence felt in Austrian affairs. While in the main the geographical distribution of the plants has not been affected, it would be sheer guesswork to give any figure of changes in refinery or storage capacities.

At least it is the concentration of Austrian oil facilities in and around Vienna that still constitutes a unique target for Allied bombing, and since the principal Austrian oilfields, and now the most vital ones for Germany, are very close to Vienna it is permissible to speak of Vienna as the Achilles heel of the tottering German oil body. Leaving aside the grave military consequences that would ensue for the German armies from the capture of the Vienna Basin by the Red Army, the loss in petroleum production would be disastrous.

With the major part of their synthetic oil production being kept in disrepair by Allied bombing, the Germans would largely have to depend on the output of the oilfields in Northwestern Germany, an output whose value is already greatly reduced by the state of the refineries.

Missouri Issues Geology Map

Special to NPN

ROLLA, Mo.—A composite picture of Missouri's mineral deposits is given in a mineral resources map of Missouri. Issuance of the map was announced by Dr. Edward L. Clark, state geologist.

The map, on a scale of 10 miles to the inch, shows general distribution of 21 different mineral resources.

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Equipment Personals

Mr. Cordry

Mr. Tatem

C. W. Cordry has been named manager of the Indianapolis district, and **D. M. Tatem** manager of the Birmingham district by the B. F. Goodrich Co., **Guy Gudaker, Jr.,** field sales manager of the tire division has announced. Both are newly formed districts.

Mr. Cordry has been general supervisor in the Cincinnati district for 18 months, also handling company operations in the Indianapolis area. He joined B. F. Goodrich in Kansas City in 1937, and served in various sales posts.

Mr. Tatem became district operating manager in Atlanta, Ga. in 1937, after holding a similar post in Philadelphia for six years. He joined the company in 1928 as office manager and chief clerk in the Philadelphia district.

* * *

Recent activities of Wayne Pump Co. include the appointment of **Robert P. Eninger** as manager of foreign sales department, appointment of **F. S. Harshbarger** as sales manager of the hoist division, and the awarding to Wayne of the third star for its Army-Navy flag.

Mr. Eninger succeeds **G. R. Amsden** who continues with the company in the general sales division. Mr. Eninger has been with Wayne for nearly 15 years. He has been active in laboratory research, sales engineering, and the promotion of power pumping equipment.

The new sales manager of the hoist division, Mr. Harshbarger, formerly of Bryn Mawr, Pa. has been vice president in charge of sales for the Globe Hoist Co., Philadelphia, for the past 10 years.

Announcement of the awarding of Wayne's third star for its Army-Navy "E" flag was announced by **B. F. Geyer,** president.

* * *

A. K. Tice has been promoted to the position of vice president and director of sales of the Fruehauf Trailer Co.

Harvey C. Fruehauf, company president, declared Mr. Tice's advancement was made "in recognition of the many contributions" he has made to the upbuilding of the company over a long period. He has been in charge of the sales department for the last several years.

Andy Beard, has been named manager of the Pharis Tire and Rubber Co.'s service store in Newark, Ohio, **Hynes Pitner,** vice president and sales manager has announced. Mr. Beard has been associated with Pharis since 1932. He was formerly on the sales force covering southern Ohio, West Virginia and Kentucky.

* * *

Fred D. Beecher has been appointed director of automotive replacement sales of the Thermoid Co., Trenton, N. J., **F. E. Schuter,** president has announced. He succeeds **Charles A. Klaus** recently resigned.

Walter Chick, who has been assisting the director of automotive replacements sales, will continue to serve in this capacity under Mr. Beecher.

* * *

G. C. Hoyt, vice president of the International Harvester Co., in charge of foreign operations, has announced the establishment by the company of scholarships under which 20 Chinese students will be trained in the U. S. as agricultural engineers.

The company also will send to China four American agricutural engineers, two of whom will be assigned to the Chinese National Agricultural Research Bureau, one to the University of Nanking and the fourth to National Central University.

The first group of Chinese students will arrive in this country March 1, the other group early in 1946.

Charles W. Springer has been appointed manager of Eastern sales by the Graver Tank & Mfg. Co., of East Chicago, Ind.

* * *

Mr. Springer was formerly sales manager of the barrel division of Jones & Laughlin Steel Co. and was a representative of the Chicago Bridge & Iron Co. He has a well-rounded background of executive sales direction in the steel plate and allied fields.

Mr. Springer

Mr. Springer will direct all of Graver's East Coast sales activities from the company's New York office.

* * *

Charles P. Clark, vice president of the Columbia Terminal Co., St. Louis, has been elected president of the National Truck Leasing System.

The system was recently incorporated under the laws of Delaware. Its objectives are toward the leasing of trucks after the war, and according to the

National Tube Employes Get 'E' Pins at Lorain Ceremony

These three employes, representing 9000 workers of National Tube Co., Lorain, O., were presented with "E" pins by Lt. Col. Alfred E. Witte, executive officer of the Cleveland Ordnance District on Jan. 17 (See NPN, Jan. 31, p. 40). L. to R. are Col. Witte; Paul E. Schremp, co-chairman of the works labor management committee and president of the local C. I. O. steelworkers union; Mrs. Mary Bogdan, who has four children in the service; and Fred W. Eisele, who has worked for 49 years at this plant

organization, is rapidly completing its plans to provide truck leasing service at any point in the United States at which such service is desired.

The system's headquarters are in Chicago.

Big Record for Little Inch

NPN News Bureau

WASHINGTON—The Little Big Inch products pipeline started its second year of operation last week and PAW Ickes noted the occasion in a statement in which he called the line "one of the country's most potent weapons of war."

In its first twelve months of operation, Ickes said, Little Big Inch delivered an average of 179,000 b/d of products to the Atlantic seaboard despite fact that capacity movement was not achieved until late last summer.

DEATHS

Parker L. Melvin

OIL CITY, PA.—Parker L. Melvin, president of the Pennsylvania Grade Crude Oil Assn. from 1940 to 1943, and Pennsylvania representative on the Interstate Oil Compact Commission, died Jan. 24 at his home in Bradford. He was 49.

Mr. Melvin was head of Towne-Melvin Oil Co. and a partner in Matson, Towne & Melvin, Bradford. He had oil producing properties in Pennsylvania and Kansas.

Member of P.I.W.C. in 1941 and 1943, Mr. Melvin served on executive committees of I.P.A.A. and of A.P.I. He was a director of the Penn Grade Crude Oil Assn. and past president and director of the Bradford District Assn. He was an officer in World War I. He is survived by his wife and three daughters.

• • •

F. R. Ficken

NEW YORK—F. R. Ficken, who retired on Dec. 1 as assistant comptroller of Socony-Vacuum Oil Co., Inc., died on Jan. 24 after a heart attack. He was 62 years old.

Mr. Ficken entered the company's employ in 1904 as a clerk in the foreign accounting department. He became chief clerk in 1911 and was appointed manager of the department in 1915. In 1933, he was named assistant controller.

• • •

Cecil B. Clark

TALLAHASSEE — Cecil B. Clark, director of the Florida Petroleum Marketers Assn., died at his residence here Jan. 15.

Mr. Clark, president of Citizens Oil Co., Tallahassee, was one of the leading independent terminal operators and suppliers in West Florida and along the Florida Gulf.

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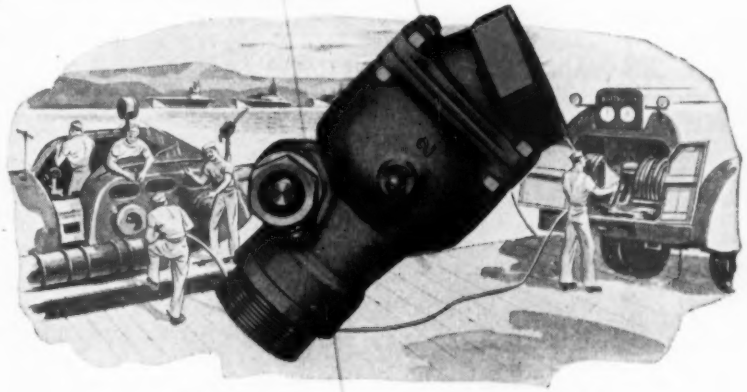

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3 Methods Used in Fixing Prices for Services But Seller Is Limited to One That Is Applicable

By Elwin E. Hadlick

One of the unfortunate features of studying price regulations is that there never seems to be an end to the job of finding out all the rules that there are to be applied to any given set of facts.

Mr. Hadlick

An oil jobber recently voiced enthusiasm at finding a price regulation provision which permitted the seller to adopt the *higher* of two prices determined by two differing methods; anyone will well understand his enthusiasm, because generally speaking when there is a choice, the rule says that the *lower* price shall prevail as the ceiling.

There is somewhat of a windfall in the price regulation relating to ceilings on services (165). Some suppliers of fuel oil have, in the days prior to the war and its consequent price regulation, given free oil burner service. This was of many and varied kinds, depending upon conditions in the local market, and many other factors.

There was a situation which called for a Houdini if anyone was to write a set of rules by which the extent to which the oil company was bound to provide free service was to be determined.

OPA took the sound view of the matter and provided that suppliers of fuel oil who had theretofore furnished free maintenance and repair services in conjunction with the sale of the oil might charge the specific prices set in the regulation for such service.

Fuel Oil Commission Sales

Incidentally, while it isn't in this price regulation, there is another provision in another regulation that the elimination of free service in connection with the sale of fuel oil did not require a reduction in the ceiling price on the oil. It's one of those breaks that does come along now and then.

We discussed last week the matter of commissions on the sale of petroleum products, and the manner in which the rates of commissions were exempt from price ceiling control by Supplementary Service Regulation No. 25 under Price Regulation 165; also the wage stabilization feature of the matter if the employer-employe relationship existed.

We are reminded to mention here the provisions of Supplementary Service Regulation No. 7, issued to become effective in some areas as long ago as December 1942. That regulation provided that in a large portion of the country any person engaged in the service of commission selling or commission distribution, from tank wagons, of fuel oil and heating oil, was permitted to charge, and any person purchasing such service was permitted to pay, three-tenths of a cent per gallon in addition to the maximum price established for such seller under the other provisions of the regulation.

If the employer-employe relationship existed, this permission would seem to be subject to the wage stabilization controls, as discussed last week. But more important, the broader permission discussed last week as applying to all petroleum products regardless of type of delivery would seem to supersede and take the place of this Regulation 7.

In the accompanying article, the 47th in his series on war-oil compliance regulations, Elwin E. Hadlick continues his discussion on ceiling prices for services. Mr. Hadlick reports that, for the time being at least, this probably will conclude discussion of this subject. Those having questions concerning any war-oil regulation are requested to communicate with Mr. Hadlick, whose address is Builders Exchange, Minneapolis 2, at the same time sending a copy of the letter to the Editor, National Petroleum News, 1213 W. 3rd St., Cleveland 13, Ohio.

General Pricing Provisions

This brings us to a consideration of the methods by which prices for services are generally determined under Price Regulation 165. We are speaking here not of the exceptions which have been discussed up to this point, but of the general run of ceiling prices on services for which there is no exception.

There are three methods of determining a price, but the seller does not have his choice of methods. He must first consider whether Method one applies; if it does he stops there; if it does not, he continues, but only until he comes to a method which does fit his situation.

The first method is the highest price at which the same service was supplied in March 1942 to a customer of the same class. This method must be used if a seller had a March 1942 price. However, the regulation does provide that if the seller, during March 1942, had a rate or a pricing method of determining his price, such rate or pricing method may be continued. The terms "rate" and "pricing method" are defined in the regulation; anyone interested should consult the definitions.

If Formula one does not apply, then a seller may charge the highest price at which he offered the same service in March 1942 to a purchaser of the same class. Again there is provision for a rate or pricing method, as in the case of the first method.

The third method, in case neither of the first two apply, is to adopt the maximum price of the closest competitor for the same service to a purchaser of the same class. Note in thise case, the evidence on which the price is based must be a competitive actual selling price and not an offering price. There is an unanswered question here: may a seller adopt a rate or pricing method used by a competitor? It would seem that he could, but the regulation is silent on the point.

Assuming a situation where a seller can meet none of the requirements of the three methods just outlined, there is still a way of determining a ceiling price. It is the method of filing an application with a district office of the OPA in which application the setting of a ceiling price is sought. The appropriate district office in which to apply is that which has jurisdiction over the area in which the business is located and in which sales are made.

An application must include a description of the service to be priced, a statement of anticipated direct labor and material costs, and a specification of the proposed maximum price. There must also be included a full explanation of the reasons why a price cannot be determined under any of the three preceding methods. Then, in order that OPA may have the entire picture, it is required that the applicant submit a description of the most comparable service if any, supplied in March 1942, showing present direct labor and material costs for it and present maximum price. There is of course the usual further requirement that the applicant must furnish any additional information required by OPA.

The provisions relative to the effectiveness of a price applied for should be noted, for they differ from the provisions in some other price regulations, notably from those relating to pricing of petroleum products under Maximum Price Regulation 88. An applicant may not sell the service for which a maximum price is requested until the price has been approved by OPA, but the price can be considered as being approved 20 days after the application is mailed to OPA or 20 days after additional data has been requested, unless, within that time, OPA notifies him that the proposed price has been disapproved.

OIL REGULATIONS

Digests of Regulations Issued Weekly Regarding Oil and Oil Equipment . . Reports of Prospective Regulations and Amendments . . Actions of Industry Committees and Meetings . . Editorial Comment, Interpretation.

Index of Week's War-Oil Orders

(January 27-February 3, 1945)

OPA—Office of Price Administration

GMPR, SR 14-H—Ceilings on certain transportation services

SR 14-I—Ceilings on storage and terminal services

SR 14-K—Ceilings on certain machinery and parts

RMPR 165, RSSR 19, Region VIII Order G-5—Oil burner services in Seattle and Tacoma areas

Region VIII Order G-6—Oil burner and stoker services in Sacramento, Calif. area

Region VIII Order G-7—Oil burner services in San Francisco and Oakland area

RMPR 436, Am. 10—Increases for high production cost stripper wells

Gen. RO 7, Am. 14—Surrender and deposit of ration stamps and coupons

Rev. RO 11, Am. 45—Rations for facilities reinstalled after 2-2-45 prohibited

WPB—War Production Board

CMP Reg. 1 as am. 1-25-45—Allotment procedure

Pri. Reg. 24 as am. 1-26-45—Purchase of equipment for nonessential civilian production and services

Release re "Brownout" Exemptions—Exemptions from Order U-9

WSA—War Shipping Administration

Rate Orders 302-312 and 314—Tanker rates, port and terminal combinations, demurrage rates from various U. S. ports

ICC—Interstate Commerce Commission

Rev. Service Order 275—Rerouting of freight traffic

Class I Motor Carrier Annual Report Form—New form for Class I contract motor carriers of property

FPC—Federal Power Commission

Docket G-611 and G-612—Panhandle Eastern Pipe Line Co. application for export of natural gas to Canada

BIR—Bureau of Internal Revenue, Treasury Dept.

Commissioner's Letter to APIC—Taxability of unloading movements involving pipeline facilities from vessels to storage tanks within wharf area

DSC—Defense Supplies Corporation

Notice to Applicants for Stripper Well Subsidies—New well statement due-date deferred to 2-15-45

NWLB—National War Labor Board

GO 31 as am. 1-26-45—Restrictions on hiring at rates in excess of minimum

VETERANS' ADMINISTRATION

Regs. under Servicemen's Readjustment Act of 1944—Eligibility of veterans for education or training

WMC—War Manpower Commission

Reclassification of Labor Market Areas (2-1-45)—Critical labor shortage area

Digest of Week's War-Oil Orders

Office of Price Administration

CEILINGS ON CERTAIN TRANSPORTATION SERVICES—GMPR, SR 14-H — Rev. Supp. Reg. 14, containing modifications of ceilings on commodities and services otherwise governed by GMPR, has been further broken down, by subjects. SR 14-H regulates 12 types of transportation, among them: Petroleum and products moved in bulk by barge, including charter rates for the Gulf and the Atlantic Intracoastal Waterways; carriers performing pick-up and delivery or local transfer service for rail, motor and water line haul carriers; charter of tugboats; carriers other than common carriers performing services within Kentucky, within Chicago metropolitan area, and New York City metropolitan area. Issued and effective 1-29.

CEILINGS ON STORAGE AND TERMINAL SERVICES—GMPR, SR 14-I—SR 14-I regulates storage and terminal services generally, and specifically controls terminal services and bulk storage of liquid commodities. But since many storage and terminal services previously considered subject to GMPR have been declared "public utilities" by a Supreme Court decision, and therefore exempt from price control, only certain restricted storage operations of interest to oil industry are covered, such as storage of packaged commodities, services connected with storage and distribution of aviation gasoline for War and Navy Depts., storage and handling of alcohol for Defense Supplies Corp., and terminal services performed in Oregon. Issued and effective 1-29.

CEILINGS ON CERTAIN MACHINERY AND PARTS—GMPR, SR 14-K — Governs, among other things, ceilings on new commercial motor vehicles, secondhand electric motors of ¾ H.P. or less, and reconditioned valves and used valves. No substantive change from provisions of old Revised SR 14. Issued and effective 1-29.

OIL BURNER SERVICES IN SEATTLE AND TACOMA CITY AREAS—RMPR 165, RSSR 19, Region VIII Order G-5—Seattle and Tacoma ceilings now cover King and Pierce Counties, Washington. Issued 1-13, effective 1-18. filed 1-26.

OIL BURNER SERVICES IN SACRAMENTO AREA—RMPR 165, RSSR 19, Region VIII Order G-6—Sacramento area redefined, by specific boundaries, to include much outlying territory. Issued 1-17, effective 1-22, filed 1-26.

OIL BURNER SERVICES IN SAN FRANCISCO AND OAKLAND AREA—RMPR 165, RSSR 19, Region VIII Order G-7—San Francisco and Oakland area defined as including a number of suburban towns. Issued 1-17, effective 1-22. filed 1-26.

INCREASES FOR HIGH-PRODUCTION-COST STRIPPER WELLS—RMPR 436, Am. 10 —(*See p.* 11, *Jan.* 31 *NPN.*)

SURRENDER AND DEPOSIT OF RATION STAMPS AND COUPONS—Gen. RO 7, Am. 14—The person turning in stamps for surrender or deposit must sign his name on the face of the envelope, which signature will constitute a certification as to the truth of the statements written on it. Issued 1-29, effective 2-2.

RATIONS FOR FACILITIES REINSTALLED AFTER 2-2-45 PROHIBITED—Rev. RO 11, Am. 45—(*See pp.* 12-13, *Jan.* 31, *NPN.*)

War Production Board

ALLOTMENT PROCEDURE—CMP 1 as am. 1-25-45—New section inserted concerning adjustments for purchases on other than authorized controlled material orders, that is, consumer must charge his allotment account with controlled materials bought under Pri. Reg. 13 or Direction 48 to CMP 1, except under certain specified circumstances. Permitted methods of disposal of Class A products which prove to be not needed, too late to prevent delivery by manufacturer, are also outlined. Issued 1-25.

PURCHASE OF EQUIPMENT FOR NON-ESSENTIAL CIVILIAN PRODUCTION AND SERVICES—Pri. Reg. 24, as am. 1-26-45—All limitation orders formerly on List A (unrated orders permitted) deleted. Unrated or non-authorized purchase orders already placed, but not shipped, at time of such deletion may not be filled, without WPB authorization specified on applicable restriction order.

EXEMPTIONS FROM PROVISIONS OF UTILITIES ORDER U-9—Release re "Brownout" Exemptions—Five areas in the U. S. including Pacific Northwest and most of Texas, have been declared exempt from U-9's provisions (prohibition of use of electricity for display lighting) as well as portions of three New York counties and four New Mexico counties, all of which use either hydro-electric power or natural gas (not scarce locally) to generate electricity. Issued 1-27.

War Shipping Administration

TANKER RATES, PORT AND TERMINAL COMBINATIONS, DEMURRAGE RATES FROM VARIOUS U. S. PORTS—WSA Rate Orders 302 through 312, and 314—Oil tanker rates set for Gulf to Atlantic ports (U.S.); U. S. Pacific ports to Canadian Pacific ports; Gulf ports to Bermuda, to Central America, and to Canal Zone; U. S. Pacific ports to Alaska and to Hawaiian Islands. Tanker rates set for transporting bulk creosote from Atlantic to Gulf ports (U. S.), for transporting benzol from Atlantic to Gulf ports (U. S.) and between U. S. Pacific ports; for transporting 50% liquid caustic soda in bulk between U. S. Pacific Coast ports and in wing tanks from U. S. Atlantic ports to Netherlands West Indies. Demurrage rates per hour for vessels under 9000 D.W.T., under 14,000 D.W.T. and over 14,000 D.W.T. are $55, $85, and $145. Issued and approved 1-22.

Interstate Commerce Commission

REROUTING OF FREIGHT TRAFFIC—Rev. Service Order 275—Area affected by Service Order 275 extended to cover 18 states and District of Columbia in northeastern section of U. S. E. W. Coughlin, 59 E. Van Buren St., Chicago, appointed ICC agent to divert or reroute loaded or empty cars when necessary, regardless of routing shown on bill of lading. Issued 1-27, effective 1-29, expires 3-31.

ANNUAL REPORTS OF CLASS I CONTRACT MOTOR CARRIERS OF PROPERTY—Annual Reports Form—Form prescribed 12-16-43 superseded by Form A, to be filed in duplicate in the Bureau of Motor Carriers, ICC,

CODE: AO—Administrative Order; CMP—Controlled Materials Plan; D—Directive; FDO—Food Distribution Order; GMPR—General Maximum Price Regulation; GO—General Order; Interp.—Interpretation; L—Limitation Order; M—Conservation Order; MPR—Maximum Price Regulation; P—Preference Rating Order; PAO—Petroleum Administrative Order; Pri. Reg.—Priorities Regulation; Proc. Reg.—Procedural Regulation; PS—Price Schedule; RO—Ration Order; RPS—Revised Price Schedule; SO—Supplementary Order; SR—Supplementary Regulation.

OIL-LAW-Gram Service

Complete texts of all orders or amendments digested in war-oil orders can be had from Platt's Oil-LAW-Gram, 1213 West 3rd street, Cleveland 13, Ohio. Minimum charge single copies $1. Copies of these texts are always in stock but large orders can be promptly filled by reprinting as plates and stencils are also kept.

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War-Oil Compliance

Washington, D. C. by March 31 of year following one to which it relates. Issued 12-26 filed 1-22, effective 1-1.

Federal Power Commission

PANHANDLE EASTERN PIPE LINE CO APPLICATION FOR EXPORT OF NATURAL GAS TO CANADA—Docket G-611 and G-612—Any requests for hearings or protests concerning application should be filed by 2-8-45 with Federal Power Commission in Washington. Jan. 6th application seeks permission to construct facilities near River Rouge, Mich., for exporting natural gas from Panhandle and Hugoton Fields to Canada, at specified rates during all months of the year except January, February, March, and December. Issued 1-24

Bureau of Internal Revenue, Treasury Department

TAXABILITY OF UNLOADING MOVEMENTS INVOLVING PIPELINE FACILITIES FROM VESSELS TO STORAGE TANKS WITHIN WHARF AREA—Letter of Commissioner to A.P.I.C.—Answer to A.P.I.C. 11-28-44 letter states that "Bureau will continue to follow the long-established rule of not considering as transportation by pipeline unloading services involving pipeline facilities from vessels or barges to the first available storage within the conceded wharf area". Issued 1-9.

Defense Supplies Corporation

NEW WELL STATEMENT DUE-DATE DEFERRED TO 2-15-45—DSC Notice to Applicants for Stripper Well Subsidies—Issued 1-22.

OPA CORRECTIONS TO STRIPPER WELL SUBSIDY LIST—DSC Letter to Applicants under Reg. 7—Minor errors in Schedule "A" corrected, as well as St. Francisville Pool, Indiana, subsidy from 25c to 35c, and Milroy Pool, Oklahoma from 25c to 35c. Issued 1-15.

National War Labor Board

RESTRICTIONS ON HIRING AT RATES IN EXCESS OF MINIMUM—GO 31 as am. 1-26-45—Whenever WMC certifies in writing to an agent of NWLB that an employer engaged in critical or essential war work has observed all WMC regulations and is faced with a critical hiring problem due to limitations of GO 31, the NWLB agent shall authorize within 5 days of certification's receipt, hiring of workers by such employer without regard to GO 31. Those hired must be persons laid off or discharged from last positions because of cutback or elimination of essential war work, or persons employed in non-critical or non-essential work, and rate may be any rate without appropriate range of job classification corresponding to ability and experience. Where rate in former job was below minimum of new employer's appropriate rate range, minimum must still be paid, but hiring of such person at above minimum rate is subject to the 25% limitation of GO 31. WMC will report details monthly to NWLB agent. Issued 1-26.

Veteran's Administration

ELIGIBILITY OF VETERANS FOR EDUCATION OR TRAINING—Regulations under Servicemen's Readjustment Act of 1944—Detailed rules set forth as to eligibility of veterans for training for various specified periods, filing of applications, necessary evidence, deductions in computing active service, payment of subsistence allowance, right of appeal, etc. Issued 1-18, filed 1-27.

War Manpower Commission

CRITICAL LABOR SHORTAGE AREAS—Reclassification of Labor Market Areas, 2-1-45—Adrian, Mich., removed from Group I (critical) to Group II, Portland, Maine, from Group II to Group III, Talledega, Ala., from Group III to Group II, and Atlantic City from Group IV to Group III. Issued 2-1.

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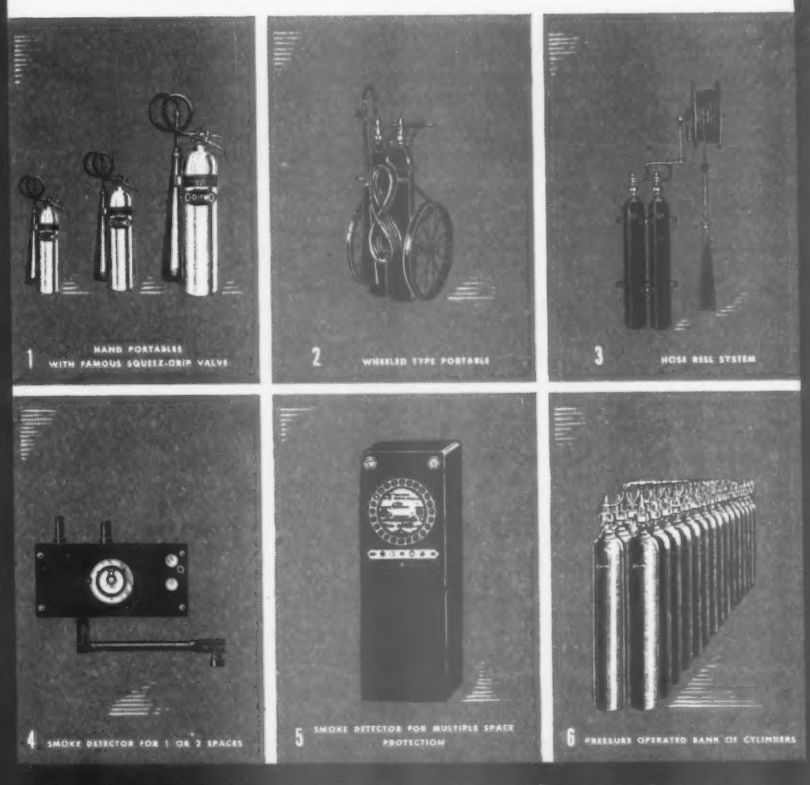
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AFFILIATED WITH PYRENE MANUFACTURING COMPANY

OWI MOTOR OUTLOOK

(*Continued from p.* 16)

amount to 57,500,000 pounds for the first quarter of 1945."

Another serious aspect of the tire (and rubber) program is the size of the stockpile of crude, natural rubber—estimated to be less than 98,000 tons on Jan. 1, 1945. Basically, the problem of producing a sufficient number of tires is inextricably interwoven with the problem of organizing increased mass production. In 1939, 1940 and 1941, the U. S. respectively processed 592,000, 648,500 and 775,000 long tons of natural rubber. About 92 per cent of this rubber was collected from plantations in the Far East.

A tabulated history of our crude rubber stocks follows:

Year Ending	Long Tons
1939	125,800
1940	268,864
1941	533,344
1942	422,714
1943	139,594
1944	98,000

This tabulation shows what has happened to our crude rubber reserves. Scrap rubber reserves sufficient for the next two years are available. Virgin crude rubber is needed in the manufacture of heavy duty tires now in extremely short supply.

To compensate for the tremendous and at one time disaster-threatening loss of crude rubber from the Far East, American industry under the auspices of the Government began a program of manufacturing synthetic rubber. Production of the three important types of synthetic rubber under this program is told in the following table:

Year Ended	Long Tons
1942	3,600
1943	207,450
1944	735,000

Natural Rubber Needed

Replacement of crude rubber by the synthetic product ranks as one of the great achievements of the war, WPR reports. The decline in the crude rubber supply, however, is of vital importance because it must still be used in a certain percentage in the manufacture of heavy truck tires.

In discussing the labor situation in tire factories, WPB officials said that the Army had released 1,500 experienced men to the factories. Several thousand additional workers are still needed to handle existing facilities.

A $70,000,000 government-financed expansion program for the manufacture of truck tires has been ordered, with some new truck tire plants expected to start production in the second quarter of this year. Plans are also being formulated for the building of more facilities to produce rayon cord and carbon black.

February quotas of tires allocated by OPA are as follows:

Passenger and motorcycle, 1,485,000 (against 1,800,000 for January and 2,000,000 for December last).

Truck and bus, 294,160 (against 326,200 for January and 400,000 for December last).

Tractor-implement, 53,360 (against

70,000 for January and 70,000 for December last).

ODT officials explained that it is possible to fill only 60 per cent of the approved top priority applications for heavy truck tires. There was a backlog of unfilled applications for 100,000 truck tires as of December 31, 1944.

Truck and bus tires manufactured in 1941 totaled 12,000,000; during 1944, fully 14,630,000. Released for rationing by OPA were 4,591,000 tires. The balance went directly or indirectly to the military.

ODT reports that commercial vehicle operators are expected to receive only about half of their estimated tire requirements during the first quarter of 1945. As claimant agency for essential commercial motor vehicle transportation, ODT requested 2,241,889 tires for new vehicles and replacement purposes for the first quarter.

Says Col. J. Monroe Johnson, ODT director:

"With trucks hauling more and more war freight, raw materials, supplies for the civilian front and produce from farms, truck operators face equipment shortages, particularly of heavy duty tires. Military demands are cutting heavily into the tire supply.

Expects Truck Layups

"Present indications are that only about 50 per cent of the essential commercial transportation tire needs will be met during the first quarter of 1945. Many trucks already are down for lack of replacement tires and, as this number can be expected to increase, a serious disruption of highway transport is possible.

"The passenger load on inter-city buses continues to mount. These lines are now carrying three passengers for every one carried before the war. Their operation becomes increasingly difficult because of shortages of replacement tires and parts and of new buses—shortages that will certainly continue into 1945."

Even used tires are in short supply, according to ODT. The extra tires turned in to the government in 1942 (11,000,000 of them) included enough serviceable or repairable tires to carry drivers through the time of the early shortage, but the most serviceable tires are practically gone now.

ODT and the former Office of the Rubber Director have continually stressed the importance of conservation in the use of tires, whether on civilian or military vehicles. They cite General Eisenhower's plea to those who run the Army's supply lines: "The war will be needlessly extended unless we extract every possible mile from our tires."

"To keep the war program rolling on rubber, everything must be done to get the most out of the available tire supply," ODT maintains. "Every driver must drive carefully, keep proper pressures, maintain a car pool and recap in time.

"Unless worn treads are recapped before the casing of the tire is ruined, there may not be enough tires on wheels to keep essential transportation running."

In addition to the tire problem, the armed services are concerned over the shortages of tire chains for military vehicles, especially those going to the battlefronts. Army officials are faced with

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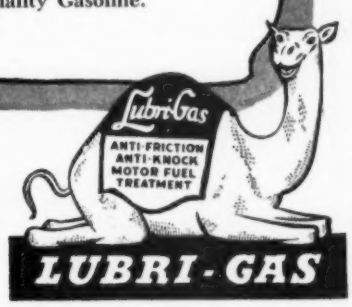

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the choice of accepting trucks without chains before shipment overseas, or holding up acceptance until the trucks can be equipped with chains, WPB said.

ODT emphasizes the following points, among others, in discussing the tire situation:

Passenger and bus tires carry four out of five workers to their jobs. Local buses carry five passengers today where formerly they carried three. Intercity buses transport three times as many passengers as before the war. Heavy-duty trucks carry more freight than ever before in history.

THE PASSENGER CAR SITUATION

The future of civilian passenger car transportation in America looks grim with automobiles disappearing from highways at the rate of about 4,000 daily or nearly 1,500,000 annually due to such factors as scarcity of tires, replacement parts and mechanical deterioration, according to the Office of Defense Transportation.

The February quota of 2,000 new 1942 cars, just announced, reveals that a cut of one-third will be made in the number of such passenger cars available for rationing in that month. OPA adds that the estimated current stockpile of new passenger cars available for rationing is now under the 12,000 level. (Note: Before rationing, 10,000 passenger cars were sold daily in the United States.)

No new passenger cars will be produced in 1945, WPB says.

Further Cut Possible

In viewing the February figure, it is not to be assumed that the new car stock pile will be exhausted in five or six months, OPA says. Reason: All 1942 cars are rationed and many persons have new car certificates, which they use to buy second-hand 1942 cars or do not use at all. An inventory check of 1942 cars is now being made by OPA. The data should be available within 60 days. If the inventory reveals that the bottom of the stockpile is imminent, there may be a still further cut in the eligibility list for new cars.

Scrapping of private passenger automobiles continues at a high rate and the total number of such cars in the hands of essential drivers is getting dangerously low. ODT, making its study from sources other than registrations, estimates that the national total of passenger cars as of Jan. 1, 1944, was 25,900,000. This figure dwindled to 24,400,000 as of Jan. 1, 1945. It is estimated that of these 24,400,000, approximately 23,750,000 are actually in use and that 650,000 are immobilized. ODT warns that if shortages of replacement and repair parts become severe, this number may increase.

Officials are convinced that it will require three record-breaking post-war years to fill the pent-up public demand for new automobiles — estimated at between 12 to 15 million cars.

ODT believes that 20,000,000 privately-owned cars in the hands of essential drivers would constitute the minimum that could keep the American civilian economy operating efficiently. Ordinarily, a margin of 3,750,000 cars over this critical number might be considered adequate, but cars that are in the hands of essential motorists are receiving hardest usage, ODT said, and consequently are breaking down first. As a result, a gradual concentration of good cars in the hands of "non-essential" drivers is already occurring.

It is difficult to determine accurately the exact number of automobiles in the United States, which are in running condition and on the highways. The Public Roads Administration has figures on registrations which are revelatory, but do not allow for sale, transfer and obsolescence. The PRA statistics follow:

Year	Automobiles	Buses*	Trucks
1941	29,524,101	88,800	4,859,244
1942	27,868,746	105,410	4,608,086
1943	25,912,730	106,702	4,480,176
1944	25,270,000	106,860	4,469,200

*Buses are registered with trucks in some states and with automobiles in others.

Transit Systems Overburdened

Local transit systems in all sections of the country except the Northeast continue to carry heavier passenger loads with each succeeding month. For the entire country the number of passengers carried has increased from 14 billion in 1941 to 23 billion in 1944. Transit systems in many large cities have more than doubled their passenger loads since the beginning of the war. Shortages of equipment and manpower mean that buses and street cars will be crowded and uncomfortable and that staggered working hours must continue, ODT said.

Production of all types of commercial and military trucks in 1944 exceeded the 1943 output by close to 70,000, with the most significant increase being in the heavies, 16,000 pounds or over, according to WPB Automotive Division. Production failed to meet the year's total program by only 5%. Despite the sharp increase in heavy truck production, achievement in these sizes was still 10% below the program. There was no civilian light-truck production in 1944.

WPB officials stated that the output of commercial and military trucks during 1944 was 743,750. This figure does not include commercial buses, half tracks or armored cars. An examination of the year's statistics discloses that there was a substantial increase in the number of light-heavies and heavy-heavies, particularly for the armored forces.

Total military and commercial truck production in 1944 was estimated as follows:

Light trucks, 247,113; medium, 175,370; heavy, 321,267. Total, 743,750.

Production of trucks in 1943 totaled 675,502 while in 1942, when civilian production was continued for the first two months, 796,927 trucks came off the assembly lines, although a relatively large part of these were lights, WPB said.

Light Civilian Trucks Coming

The 1945 production program has been established as 869,212 trucks of all weights and categories (including half tracks and armored cars), or about 60,000 more than the comparable 1944 program. An important increase in the new program is that of 40,000 light truck units for civilians where as there was no light production for civilians in 1944. The 1945 production will be allocated as follows: ODT, 186,792; FEA, 56,511; Maritime Commission, 675; Canada, 55; Off-Highway use, 1,416. The balance represents direct and indirect military allocations. The 1945 truck program may be subject to change with revisions in military requirements.

WPB's estimated 1945 truck program may be summarized as follows:

Light trucks, 296,985. By quarters: 69,005, 77,494, 75,830, 74,656.

Medium trucks, 184,436. By quarters: 50,411, 45,624, 44,348, 44,053.

Light heavy trucks, 322,734. By quarters: 82,096, 80,756, 81,047, 78,835.

Heavy-heavy trucks, 65,057. By quarters: 19,992, 18,055, 15,430, 11,580.

All trucks, 869,212. By quarters: 221,504, 221,929, 216,655, 209,124.

The 1945 commercial trailer program, important to both industry and transportation, was announced by WPB by quarters as follows:

First quarter, 7,232; second quarter, 5,000; third quarter, 5,000; fourth quarter, 5,000; total for year, 22,232.

Less than one-fourth of the motor trucks estimated as needed to meet essential civilian transportation requirements during 1945 will be produced and distributed to commercial operators. Authorized civilian program amounts to 186,792 light, medium, light heavy and heavy trucks or 21.4% of ODT's stated requirement of 773,935 vehicles.

ODT, as claimant agency for commercial vehicles estimates that farm trucks

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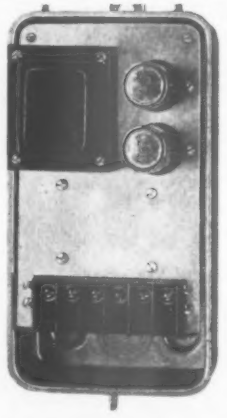

and off-the-highway farm vehicles totaled 1,550,000 in 1944 and will total 1,630,000 in 1945. The average age of farm trucks is between 7-8 years. The nation's farmers, WFA estimated, could use 200,000 new trucks this year, but probably will get about 60,000.

BATTERIES

Currently the greatest threat to U. S. transportation — military and civilian — comes from the shortage of lead, material used in the manufacture of batteries. A decreased lead supply will require a 40% cut in metal available for civilian batteries.

The 1945 lead supply will be approximately 20 per cent below requirements, it is estimated. Curtailment of lead construction for all non-military uses seems to be unavoidable. Lead assigned for civilian battery construction may be cut from about 224,000 tons in 1944 to 143,000 tons in 1945.

ODT estimates that storage battery requirements in 1945 will amount to 19,000,000 units. There is no significant reserve of storage batteries. Reason: Such batteries cannot be stockpiled. If ODT's estimates of battery requirements are verified in the face of anticipated shortages, vehicles will disappear from the highways at a progressively increasing rate.

BUSES

With the transportation load on buses increased in some war-producing areas from 25 to 250 per cent, production of new commercial carriers in 1945 will double the 1944 output, according to information provided by the WPB Automotive Division.

In reviewing the commercial bus situation, the Automotive Division said that 1944 production will total 5,087. This figure includes the December forecast. This is more than three times greater than the number of commercial carriers made in 1943 when the production totaled 1,613. This low 1943 production was attributable to the lateness in authorizing the bus program and the existence of some "very weak months." On the other hand, production was extremely high in 1942 when trucks were badly needed as war production got under way. The 1942 output was 8,337.

Slightly fewer than 10,000 commercial buses are scheduled for production in 1945, or almost double the 1944 figure. WPB officials explained that this is necessitated by the fact that many buses have outlived their usefulness.

The impact on public carriers has increased tremendously as a result of breakdown of automobiles, gasoline rationing, scarcity of tires and spare parts and other factors.

WPB's summary of production of buses in 1944 follows: Integral buses, 5,000; body-on-chassis buses, 8,380; Army and Navy body-on-chassis buses, 2,500.

SPARE PARTS

Production of permitted spare parts for civilian needs was accelerated in 1944 to reach an all-time record value of $750,000,000, it was revealed by the WPB Automotive Division. Production jumped from approximately $162,000,000 in the first quarter to about $210,000,000 in the fourth quarter. An additional load, at least as great as the civilian, was placed on the industry to provide spare parts for military use, officials said.

The high-rate production is expected to continue throughout 1945, WPB said. For comparative purposes, the Automotive Division revealed that 1943 production of these "functional" spare parts totaled $440,000,000 while in 1942 it was $330,000,000.

THE LABOR SITUATION

In discussing the labor situation as it affected the automotive industry in 1944, WPB officials said that the labor supply improved somewhat during the year, and they hope that it will look "healthier" in 1945.

Importation of Barbados and Jamaica labor was effective in alleviating employment conditions in some critical areas. The chief labor bottleneck during 1944 was in the forge shops and foundries. The foundries are continuing to suffer from severe manpower shortages.

Labor prospects in 1945 are considered generally favorable, though there will be the usual losses due to seasonal conditions.

About 6000 more workers could be used immediately for machine shops, production of end products and in the assembly plants, officials said. About 850,000 workers are employed in plants owned or operated by the automotive industry.

One of the highlights of the year was the critical shortage of castings, created to a large measure by the insufficiency of labor and management at the foundry level. This shortage is expected to continue in 1945, though the problem is being gradually solved.

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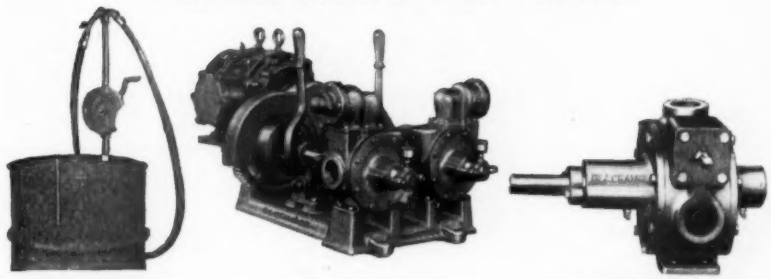

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WRITE FOR BULLETIN NO. 102: Pumps for the Petroleum Industry

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Market Reports

ATLANTIC COAST — Suppliers earlier in week were somewhat optimistic that a break in the weather coupled with the "72-hour embargo" on freight shipments would ease the critical fuel oil shortage throughout the New York area. However, further storms made it again necessary to place another embargo on shipments and further complicated the supply problem. Kerosine was reported so scarce that many distributors are entirely without product.

° ° °

GULF COAST — Prices remained unchanged throughout the week. Markets were generally unchanged with all refined products closely held. Heavy demand for residuals reported.

° ° °

PENNSYLVANIA — Continued snow storms and cold weather are still hampering production of crude throughout all Western Pennsylvania markets. Short haul transportation is reported unimproved with a shortage of transport trucks impeding deliveries. Lube oil demands so heavy refiners are "hard put" to fill any orders other than government commitments.

° ° °

MIDWEST — No price changes. Although supplies of all products are short, transportation is still the big bottleneck. Refiners and marketers report that tank cars are very difficult to obtain and when any are received and shipments sent out, the tank cars do not come back.

Serious shortage of fuel oil is anticipated in Michigan before the winter is over, and all exports to Dist. 1 from that area either have been or are being discontinued in an effort to head off the prospective shortage. A reduction in crude runs for February, partly due to severe weather slowing up production and laying up crude hauling trucks, accounts for some of the product shortage.

Delivered-at-destination prices on light burning oils are now being worked out by OPA and are to be made effective as soon as the industry has had an opportunity to study the proposed amendment to MPR 88, which is to be circulated for that purpose.

° ° °

CALIFORNIA — Supplies of second grade gasoline were increasing here last week as service stations reported their sales were off. Heating oils still were in heavy demand as rainy weather struck the coast. All residuals were tight.

° ° °

MIDCONTINENT—Prices remained unchanged during the week. One open spot sale was reported by West Texas refiner of 50 cars No. 6 fuel oil at 97c for shipment in buyer's cars during February to Dist. 1. Demand for residual continues heavy, refiners say.

Burning oils and kerosine demand continues without letup. North Texas refiner who until now had not found it necessary to prorate said he was having to limit local customers' February and March takings of kerosine to 60% of December purchases. Oklahoma refiner said he was three weeks behind on orders for No. 1 due to lack of material and transportation; even after cancelling some orders entirely he is having to substitute kerosine to fill others, he added.

Gasoline demand continues good for this season. Estimates of sales of all grades during January as compared with year ago by Oklahoma and Kansas refiners range from 2-8% increase.

Eight cars Grade 26-70 natural gasoline were reported sold at 4.75c f.o.b. Group 3, and 13 cars were reported sold at 4.375c f.o.b. Breckenridge.

N.P.N. Gasoline Index

	Dealer T.W.	Tank Car
	Cents Per Gal.	
Feb. 5	10.39	6.73
Month ago	10.38	6.72
Year ago	10.51	6.83

Dealer index is an average of "undivided" dealer prices, ex-tax, in 50 cities.

Tank car index is weighted average of following wholesale markets for regular-grade gasoline, FOB refineries or terminals: Okla., Mid-Western, W. Penna., Calif., N. Y. Harbor, Philadelphia, Jacksonville, Boston and Gulf Coast.

Daily Av. Pennsylvania Crude Runs

(Compiled by National Petroleum Assn. from reports of all companies refining Pennsylvania crude. Figures in bbls.)

Week Ended Jan. 27, 1945	Week Ended Jan. 20 1945	Week Ended Jan. 29 1944
55,804	59,340	71,485

CRUDE PRICES

Since changes in crude oil prices are so few, the two pages of crude oil price tables hereafter will be printed only when there are sufficient changes in prices to warrant.

In the meantime a record is being kept in the Cleveland office of NPN and OILGRAM from which the publishers will be glad to make proofs, or letters or affidavits as to what the prices are, and without charge to regular subscribers. Changes in crude oil prices will be specially noted in this market section when made.

Crude Price Changes

No price changes announced in week ending Jan. 31.

For latest table of crude prices published, see NPN, Jan. 31, pages 54, 55 and 48.

Summary of Daily Gasoline Prices (January 29 to February 5)

U. S. Motor (ASTM octane) 76 octane Ethyl:	Monday Feb. 5	Friday Feb. 2	Thursday Feb. 1	Wednesday Jan. 31	Tuesday Jan. 30
Oklahoma	6.75	6.75	6.75	6.75	6.75
Mid-Western (Group 3 basis)	6.75	6.75	6.75	6.75	6.75
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	7	7	7	7	7
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	7 (2)	7 (2)	7 (2)	7 (2)	7 (2)
70-74 octane:					
Oklahoma	5.875	5.875	5.875	5.875	5.875
Mid-Western (Group 3 basis)	5.875	5.875	5.875	5.875	5.875
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.875	5.875	5.875	5.875	5.875
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.875	5.875	5.875	5.875	5.875
63-66 octane:					
Oklahoma	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)
Mid-Western (Group 3 basis)	5.625 (2)	5.625 (2)	5.625 (2)	5.625 (2)	5.625 (2)
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)
60 octane & below:					
Oklahoma	5.25	5.25	5.25	5.25	5.25
Mid-Western (Group 3 basis)	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.25	5.25	5.25	5.25	5.25
Motor Gasoline, 70-74 oct.					
New York harbor	9.075	9.075	9.075	9.075	9.075
New York harbor, barges	8.975	8.975	8.975	8.975	8.975
Philadelphia district	9.075	9.075	9.075	9.075	9.075
Baltimore district	8.825	8.825	8.825	8.825	8.825
Motor Gasoline:					
Western Penna. Bradford-Warren:					
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.625- 8.225	7.625- 8.225	7.625- 8.225	7.625- 8.225	7.625-8.225
Western Penna. Other Districts:					
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.725	7.725	7.725	7.725	7.725

Note: To conform with Article IV of MPR 88 as amended August 15 we are substituting 70-74 oct. ASTM for the old 72-74 oct. ASTM. We continue to include in this group, Housebrand quotations.

REFINERY OPERATIONS

(American Petroleum Institute figures in thousands of barrels of 42 gal. each. Figures include reported totals plus estimate of unreported amounts and are therefore on a Bureau of Mines basis.)

Districts	Daily Average Crude Runs to Stills Week Ended		Gasoline Production at Refineries inc. Natural Blended Week Ended		Kerosine Production Week Ended		Gas Oil & Dist. Fuel Oil Production Week Ended		Residual Fuel Oil Production Week Ended		Total Stocks Kerosine Week Ended	
	Jan. 27	Jan. 20	Jan. 27	Jan. 20	Jan. 27	Jan. 20	Jan. 27	Jan. 20	Jan. 27	Jan. 20	Jan. 27	Jan. 20
East Coast	774	735	1,927	1,730	205	192	1,124	885	1,742	1,676	3,375	3,366
Appalachian (Dist. No. 1)	103	103	308	282	64	62	80	87	121	89	484	493
Appalachian (Dist. No. 2)	59	57	192	164	3	17	44	45	94	92	49	61
Ind., Ill., Ky.	799	772	3,029	2,959	273	258	615	682	1,192	1,144	2,002	2,065
Okla., Kans., Mo.	395	390	1,446	1,368	171	159	415	445	516	514	529	566
Inland Texas	225	240	881	970	81	91	129	133	412	464	140	160
Texas Gulf Coast	1,123	1,111	3,444	3,362	500	454	1,364	1,380	1,841	1,772	1,461	1,246
Louisiana Gulf Coast	289	245	940	828	231	210	376	297	309	320	678	792
No. La., & Arkansas	76	82	196	204	48	54	69	73	118	125	249	149
Rocky Mt. (Dist. No. 3)	10	11	33	37	4	4	8	8	29	30	10	10
Rocky Mt. (Dist. No. 4)	118	124	390	391	23	20	69	66	209	249	104	97
California	785	816	2,171	2,259	70	35	550	485	2,669	2,607	400	440
Total U. S.—B. of M. Basis	4,756	4,686	14,957	14,554	1,673	1,556	4,843	4,586	9,252	9,082	9,481	9,445
U. S.—B. of M. Basis Jan. 29, 1944	4,364		13,294		1,631		4,196		8,700		8,314	

Districts	Total Stocks Gas Oil and Distillates Week Ended		Total Stocks Residual Fuel Oil Week Ended		Gasoline Stocks—Military and Other Week Ended		Gasoline Stocks—Civilian Grade Week Ended	
	Jan. 27	Jan. 20	Jan. 27	Jan. 20	Jan. 27	Jan. 20	Jan. 27	Jan. 20
East	6,955	7,858	4,951	5,215	6,391	6,379	5,857	5,975
Appalachian (Dist. 1)	419	362	277	288	1,399	1,366	1,221	1,286
Appalachian (Dist. 2)	237	216	243	249	605	614	1,135	1,085
Ind., Ill., Ky.	4,925	5,290	2,693	2,774	6,156	6,107	14,324	13,991
Okla., Kans., Mo.	1,949	1,970	1,278	1,284	2,256	2,097	6,822	6,662
Inland Texas	384	381	661	656	1,045	1,128	1,702	1,695
Texas Gulf Coast	6,817	6,817	8,848	9,147	10,112	9,989	5,397	5,265
Louisiana Gulf Coast	1,276	1,368	1,336	1,359	2,360	2,368	2,143	1,870
N. La. and Arkansas	842	781	259	263	976	971	1,780	1,867
Rocky Mt. (Dist. 3)	20	20	28	28	10	15	71	66
Rocky Mt. (Dist. 4)	340	346	550	526	575	567	1,221	1,164
California	9,487	9,632	29,995	30,765	10,926	11,307	4,739	4,856
Total U. S.—B. of M. Basis	33,651	35,041	51,119	52,554	*42,811	42,926	46,412	45,782
U. S.—B. of M. Basis Jan. 29, 1944	37,251		52,980		36,346		44,571	

*Includes aviation, military, solvents and naphthas and gasoline blending stocks currently indeterminate as to ultimate use and 11,689,000 barrels of unfinished gasoline this week, compared with 12,167,000 barrels last week (revised) and 11,893,000 barrels a year ago.

Percent Daily Refining Capacity Reporting—East Coast, 100.0; Appalachian (Dist. 1) 83.9, (Dist. 2) 87.2; Ind., Ill., Ky., 85.2; Okla., Kans., Mo., 80.2; Inland Texas, 66.9; Texas Gulf Coast, 90.5; Louisiana Gulf Coast, 95.5; No. Louisiana & Arkansas, 68.0; Rocky Mt. (Dist. 3) 17.0, (Dist. 4) 58.3; California, 89.9; Total U. S.—B. of M. Basis Jan. 27, 1945, 87.2; Total—B. of M. Basis Jan. 20, 1945, 87.2.

U. S. Crude Oil Production

(American Petroleum Institute figures)

	WEEK ENDED Barrels (Daily Average) Jan. 27	Barrels (Daily Average) Jan. 20
Oklahoma	361,900	362,500
Kansas	267,250	276,500
Nebraska	950	1,000
Texas	2,135,150	2,135,150
Louisiana	357,200	358,200
Arkansas	81,300	81,700
Mississippi	48,850	47,600
Alabama	300	250
Florida	50	50
Illinois	201,050	198,250
Indiana	12,600	12,550
Eastern (Ill., Ind. & Ky. excluded)	57,500	63,800
Kentucky	29,450	30,450
Michigan	46,700	42,550
Wyoming	98,000	99,750
Montana	20,400	20,400
Colorado	10,050	9,450
New Mexico	103,150	103,150
California	895,300	890,400
Total, U. S.	4,727,150	4,733,750

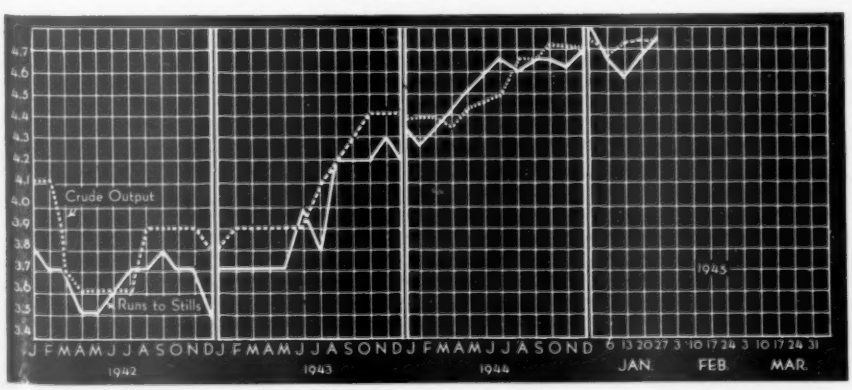
Crude Oil Stocks

(Bureau of Mines Figures in thousands of bbls.)

Grade or Origin	Jan. 20	Jan. 27	Change from Jan. 20
Penna. Grade	2,060	2,061	+ 1
Other Appalachian	1,509	1,522	+ 13
Lima-Michigan	1,003	992	— 11
Illinois-Indiana	14,138	14,151	+ 13
Arkansas	2,817	2,807	— 10
Kansas	8,517	8,275	—242
Louisiana	13,303	13,085	—218
Northern	3,348	3,222	—126
Gulf Coast	9,955	9,863	— 92
Mississippi	1,034	1,194	+160
New Mexico	7,072	7,080	+ 8
Oklahoma	30,605	30,960	+ 85
Texas	110,610	110,912	+302
East Texas	18,215	18,113	—102
West Texas	32,021	32,923	+902
Gulf Texas	31,867	31,988	+121
Other Texas	28,507	27,888	—619
Panhandle	5,589	5,516	— 73
North	7,455	7,239	—216
South	6,449	5,858	—591
Other	9,014	9,275	+261
Rocky Mountain	6,709	6,538	—171
California	19,886	20,158	+272
Foreign	2,383	1,845	—538
Total gasoline-bearing in U. S.	221,646	221,310	—336
Heavy in California	6,014	5,941	— 73

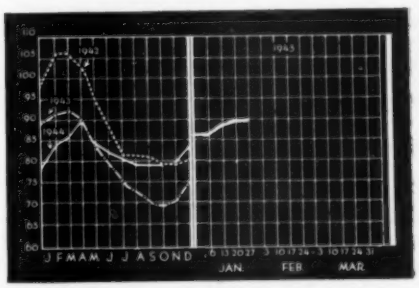
Crude Production & Runs to Stills

(Millions of Barrels)


Crude Output
Runs to Stills
1943
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D 6 13 20 27 3 10 17 24 3 10 17 24 31
1942
1943
1944
JAN.
FEB.
MAR.

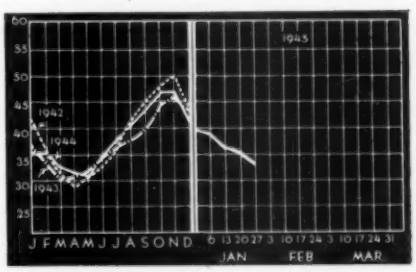
Gasoline Stocks

(Millions of Barrels)



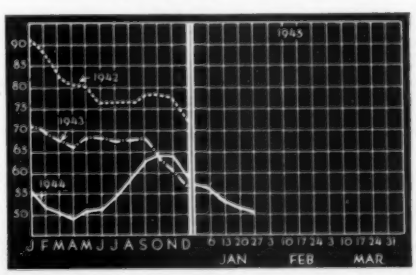
Gas Oil & Distillate Stocks

(Millions of Barrels)



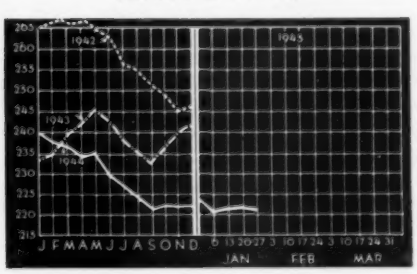
Residual Fuel Oil Stocks

(Millions of Barrels)



Crude Oil Stocks

(Millions of Barrels)



OIL PRICE SECTION

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At Refineries and Terminals and by Tank Wagon

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Refinery Prices

Gasoline —U. S. Motor (A S T M) except where otherwise specified.

Prices in Effect	Feb. 5	Jan. 29
OKLAHOMA		
76 oct. Ethyl...	6.75	6.75
70-74 oct.....	5.875	5.875
63-66 oct.....	5.625 (1)	5.625 (1)
60 oct. & below.	5.25	5.25
MID-WESTERN (Group 3 basis)		
76 oct. Ethyl...	6.75	6.75
70-74 oct.....	5.875	5.875
63-66 oct.....	5.625 (2)	5.625 (2)
60 oct. & below.	5.2 - 5.25	5.2 - 5.25
N. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
76 oct. Ethyl...	7	7
70-74 oct.....	5.875	5.875
63-66 oct.....	5.625 (1)	5.625 (1)
60 oct. & below.	5.2 - 5.25	5.2 - 5.25
W. TEX. (For shpt. to Tex. & N M. dest'ns.)		
76 oct. Ethyl...	7 (2)	7 (2)
70-74 oct.....	5.875	5.875
63-66 oct.....	5.625(1)	5.625 (1)
60 oct. & below.	5.25	5.25
CENT. W. TEX. (Prices to truck transports)		
76 oct.....	7 (2)	7 (2)
70-74 oct.....	5.875 (2)	5.875 (2)
67-69 oct.....	....	....
62 oct. & below.	5.25 (2)	5.25 (2)
KANSAS (For Kansas destinations only)		
76 oct. Ethyl...	7.2 - 7.3	7.2 - 7.3
70-74 oct.....	6.2	6.2
63-66 oct.....	5.9 (2)	5.9 (2)
60 oct. & below.	5.5	5.5
ARK. (For shipment to Ark. & La.)		
76 oct. Ethyl...	7 (1)	7 (1)
70-74 oct.....	5.875 (1)	5.875 (1)
62 oct. "	....	....
60 oct. & below, unleaded.....	5.25 (1)	5.25 (1)
WESTERN PENNA. (Motor gasoline)		
Bradford-Warren:		
"Q" Gasoline Min. 70 Oct. (ASTM)	7.625-8.225(a)	7.625-8.225(a)
Other districts		
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.725	7.725

(a) Highs and lows for Schedule D area, in MPR 88 and outside Schedule D area, respectively.

Prices in Effect	Feb. 5	Jan. 29
CENTRAL MICHIGAN (FOB Central Mich. refinery group basis for shpt. within Mich.; shpts. may originate at plants outside Central group.)		
U.S. Motor: (Oct. ASTM):		
70-74 oct.....	7.875- 8.375	7.875- 8.375
75-78oct.....	9(1)	9(1)
Str. run gasoline, exoluding Detroit shpt.....	6	6
OHIO (S. O. Ohio quotations for statewide delivery and subject to exceptions for local price disturbances).		
70-74 oct.....	8.25	8.25
CALIFORNIA U.S. Motor:		
76 oct. (Ethyl)....	8 - 8.75	8 - 8.75
70-74 oct.....	7 - 7.5	7 - 7.5
65 oct. & below (3rd grade).....	5.75 - 6.25	5.75 - 6.25

Kerosine, & Gas Fuel Oils

Prices in Effect	Feb. 5	Jan. 29
OKLAHOMA		
41-43 grav. w.w...	4.375	4.375
42-44 grav. w.w...	4.5	4.5
Range oil.....	4	4
No. 1 p.w.....	3.875	3.875
No. 1 straw.....	....	....
No. 2 straw.....	3.625	3.625
No. 3 fuel.....	3.5 (2)	3.5 (2)
No. 6 fuel.....	$0.90-$0.97	$0.90-$0.97
U. G. I. Gas Oil..	....	....
14-16 fuel.....	$0.97 (2)	$0.97 (2)
MID-WESTERN (Group 3 basis)		
41-43 grav. w.w...	4.375	4.375
42-44 grav. w.w...	4.5	4.5
Range Oil.....	4 -4.1 (2)	4 -4.1 (2)
No. 1 p.w.....	3.875	3.875
No. 2 straw.....	3.625	3.625
No. 3.....	....	....
No. 5.....	....	....
No. 6.....	$0.97 (1)	$0.97 (1)
N. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
41-43 grav. w.w...	4.375	4.375
42-44 grav. w.w...	4.5 (1)	4.5 (1)
No. 1 p.w.....	3.875 (1)	3.875 (1)
No. 6 fuel.....	$0.90-$0.97(2)	$0.90-$0.97(2)
AMARILLO, TEX. (For shpt. to W. Okla. & Tex. differential territory.)		
42-44 grav. w.w...	4.5 (1)	4.5 (1)
KANSAS (For Kansas destinations only).		
41-43 grav. w.w...	No Price	No Price
42-44 grav. w.w...	4.7	4.7
No. 1 p.w.....	4.1	4.1
No. 6 fuel.....	$0.95-$1.02	$0.95-$1.02
ARK. (For shipment to Ark. and La.)		
41-43 grav. w.w...	....	....
42-44 w.w. kero...	4.5 (1)	4.5 (1)
No. 1.....	....	....
No. 2.....	3.625 (1)	3.625 (1)
No. 3 fuel.....	3.5 (1)	3.5 (1)
Tractor fuel, for shpt. to Ark. points only.....	5.125 (1)	5.125 (1)
Diesel fuel 52 & below.....	4 (1)	4 (1)
Diesel fuel 58 & above.....	4.25 (1)	4.25 (1)
WESTERN PENNA.		
Bradford-Warren:		
45 grav. w.w.....	6.5 - 7.55	6.5 - 7.55
46 grav. w.w.....	.....	.....
No. 1 fuel.....	6.55-7.55(2&b)	6.55-7.55(2&b)
No. 2 " ...	6.125-7.125(2&b)	6.125-7.125(2&b)
No. 3 "	6.25-7.25(1&b)	6.25-7.25(1&b)
36-40 gravity.....	6.625-6.75(2)	6.625-6.75(2)

(b) Highs and lows for Schedule D area, in MPR 88 and outside Schedule D area, respectively.

Other districts:		
45 grav. w.w.....	7 - 7.425	7 - 7.425
46 grav. w.w.....	7.25 - 7.375	7.25 - 7.375
47 grav. w.w.....	7.375- 7.50	7.375- 7.50
No. 1 fuel.....	6.875- 7.125	6.875- 7.125
No. 2 "	6.75 - 6.875	6.75 - 6.875
No. 3 "	6.75	6.75
36-40 grav. Pittsburgh dist. prices excluded.....	6.625-6.875	6.625- 6.875
CENTRAL MICHIGAN (FOB Central Mich. refinery group basis for shpt. within Mich.; shpts. may originate at plants outside Central group.)		
47-49 gravity w.w.	5.8 - 6	5.8 - 6
P.W. Distillate...	5.5	5.5
No. 3 gas oil, Straw	5	5
U.G.I. gas oil.....	4.5 (2)	4.5 (2)
Fuel Oils (*Vis. at* 100).		
300-500 Vis.....	4.14 (1)	4.14 (1)
100-300 Vis.....	4.5	4.5
OHIO (S. O. quotations for statewide delivery)		
Kerosine.....	7	7

Prices in Effect	Feb. 5	Jan. 29
CALIFORNIA		
40-43 grav. w.w...	5 - 7	5 - 7
San Joaquin Valley:		
Heavy fuel.....	$1.10 (2)	$1.10 (2)
Light fuel.....	$1.20 (2)	$1.20 (2)
Diesel fuel.....	4 (2)	4 (2)
Stove dist.....	5 (2)	5 (2)
Los Angeles:		
Heavy fuel.....	$1.10 (2)	$1.10 (2)
Light fuel.....	$1.20 (2)	$1.20 (2)
Diesel fuel.....	4 (2)	4 (2)
Stove dist.....	5 (1)	5 (1)
San Francisco:		
Heavy fuel.....	$1.15 (1)	$1.15 (1)
Light fuel.....	$1.25 (1)	$1.25 (1)
Diesel fuel.....	4.5 (1)	4.5 (1)
Stove dist.....	5.5 (1)	5.5 (1)

NOTE: All above heavy fuels meet Pacific specification 400; light fuel, spec. 300; Diesel fuels, spec. 200; and stove distillate, spec. 100.

Lubricating Oils

Prices in Effect	Feb. 5	Jan. 29
WESTERN PENNA.		
Prices are for sales made, or offers reliably reported, to jobbers & compounders only.		
Viscous Neutrals—*No. 3 col. Vis. at* 70°*F.*		
200 Vis. (180 at 100°) 420-425 fl.		
0 p.t.....	38 (1)	38 (1)
10 p.t.....	37 (1)	37 (1)
15 p.t.....	36 (1)	36 (1)
25 p.t.....	28-33	28-33
150 Vis. (143 at 100°) 400-405 fl.		
0 p.t.....	36 (1)	36 (1)
10 p.t.....	35 (1)	35 (1)
15 p.t.....	34 (1)	34 (1)
25 p.t.....	26-31	26-31

NOTE: Limited quantity neutrals available to regular trade.

Cylinder Stocks:

Brt. stk., 145-155 *vis. at* 210°, 540-550 fl., *No.* 3 *col.*		
10 p.t.....	30.5 (1)	30.5 (1)
15 p.t.....	29.5 (1)	29.5 (1)
25 p.t.....	25	25
600 S.R. filterable	15	15
650 S.R.....	15.5	15.5
600 fl.....	16	16
630 fl.....	17	17

MID-CONTINENT (F. o. b. Tulsa)

Neutral Oils (*Vis. at* 100° *F. 0 to* 10 *P.P.*)

Pale Oils: Vis. Color		
60-85—No. 2....	7.5	7.5
86-110—No. 2...	7.5 - 8.5	7.5- 8.5
150—No. 3.....	11 -11.5	11 -11.5
180—No. 3.....	11.5 -15	11.5-15
200—No. 3.....	12 -15	12 -15
250—No. 3.....	14 -16.5	14 -16.5
280—No. 3.....	15 -17	15 -17
300—No. 3.....	16 -18	16 -18
Red Oils:		
180—No. 5.....	11.5 (1)	11.5 (1)
200—No. 5.....	12 (1)	12 (1)
280—No. 5.....	No Price	No Price
300—No. 5.....	16-17.5(2)	16-17.5 (2)
Bright Stock—*Vis. at* 210°		
200 Vis. D.....	27 (1)	27 (1)
150-160 Vis. D:		
0 to 10 p.p.....	23	23
10 to 25 p.p.....	22.5-23	22.5-23
25 to 40 p.p.....	23 (1)	23 (1)
150-160 Vis. E....	22 (1)	22 (1)
120 Vis. D:		
0 to 10 p.p.....	22 (2)	22 (2)
600 S.R. Dark Green.....	8.5 (1)	8.5 (1)
600 S.R. Olive Green.....	10-11 (2)	10-11 (2)
631 S.R.....	....	....
Black Oil.....	....	....

NOTE: Discounts of 0.5c to 1c on bright stock and 0.5c to 2c allowed for neutrals, 10 car lots, and to "meet competition." Brokers offering at greater discounts.

SOUTH TEXAS (Neutral Oils)

Pale Oils (*Vis. at* 100°*F.*) Vis. Color		
100 No. 1½-2½.	6.5	6.5
200 No. 2-3.....	8.75	8.75
300 No. 2-3.....	9.25	9.25
500 No. 2½-3½.	10	10
750 No. 3-4.....	10.25	10.25
1200 No. 3-4.....	10.375	10.375
2000 No. 4.....	10.5	10.5

(Continued on next page)

NOTE—Parenthetical figures after prices indicate number of companies quoting when less than three companies are quoting.

NOTICE—Owing to great demand, refiners generally limit quotations to regular customers and refuse bids, though higher, from others. Refiners' prices and sales shown; bids reported in market leads

Refinery Prices (Continued)

Prices in Effect	Feb. 5	Jan. 29
Red Oils:		
100 No. 5-6	6.5 (2)	6.5 (2)
200 No. 5-6	8.75	8.75
300 No. 5-6	9.25	9.25
500 No. 5-6	10	10
750 No. 5-6	10.25	10.25
1200 No. 5-6	10.375	10.375
1000 No. 5-6	10.5	10.5

CHICAGO (From Mid-Continent p.l. crude.) Neutral oils *vis. at* 100° *F. 0 to 10 p.p.*

Pale Oils Vis. Color		
60-85—No. 2	9 (1)	9 (1)
86-110—No. 2	9.25 (1)	9.25 (1)
150—No. 3	12.5 (1)	12.5 (1)
180—No. 3	13 (1)	13 (1)
200—No. 3	13 (1)	13 (1)
250—No. 3	14 (1)	14 (1)
Red Oils:		
180—No. 5	13 (1)	13 (1)
200—No. 5	13 (1)	13 (1)
250—No. 5	14 (1)	14 (1)
280—No. 5	15 (1)	15 (1)
300—No. 5	15.5 (1)	15.5 (1)

Note: Viscous oils, 15 to 30 p.p. are quoted 0.5c lower; 60-85 and 86-110 No. 2 non-viscous oils, 15 to 30 p.p., 0.25c lower.

Unfiltered Steam Refined (*Viscosity at* 210°)		
140	11.5 (1)	11.5 (1)
160	12.5 (1)	12.5 (1)
200	13.5 (1)	13.5 (1)
Bright stocks, 160 *vis. at* **210** *No. 8 color:*		
0 to 10 p.p.	24 (1)	24 (1)
15 to 25 p.p.	23.5 (1)	23.5 (1)
30 to 40 p.p.	21.5 (1)	21.5 (1)
E filtered Cyl. Stock	15.5 (1)	15.5 (1)

Note: To obtain prices delivered in Chicago add 0.25c per gal.

Natural Gasoline

(Group 3 & Breckenridge prices are to blenders on freight basis shown below. Shipments may originate in any Mid-Continent manufacturing district.

FOB GROUP 3

Grade 26-70.... 4.75 (Sales) 4.75 (Sales)

FOB BRECKENRIDGE

Grade 26-70.... 4.375 (Quote) 4.375 (Sales)

CALIFORNIA (FOB plants in Los Angeles basin)

21 pound vapor pressure for blending	4.75 - 5.375	4.75 - 5.375

Naphtha and Solvent

(*FOB Group* 3)

Stoddard solvent	6.625	6.625
Cleaners' naphtha	7.125	7.125
V.M.&P. naphtha	7.1 - 7.125	7.1 - 7.125
Mineral spirits	6.1 - 6.125	6.1 - 6.125
Rubber solvent	7.1 - 7.125	7.1 - 7.125
Lacquer diluent	7.375- 8.125	7.375- 8.125
Benzol Diluent	7.875- 8.625	7.875- 8.625

WESTERN PENNA.

Other Districts:

Untreated naphtha	7 -7.25 (2)	7 -7.25 (2)
Stoddard solvent	7.25 -7.5 (2)	7.25 -7.5 (2)

OHIO (S. O. quotations for statewide delivery): V.M.&P. naphtha. D.C. naphtha, Varnolene &

Sohio solvent	10	10
Rubber solvent	9	9

Wax

WESTERN PENNA. (Bbls. C.L.)

White Crude Scale:		
122-124 A.m.p.	4.25 (2)	4.25 (2)
124-126 A.m.p.	4.25	4.25

OKLAHOMA (C.L. FOB Refinery)

Semi-refined:		
128 AMP min., white, 50 kilo bags	No Price	No Price
132-134 AMP, bbls.	5(1)	5(1)

CHICAGO (FOB Chicago district refinery of one refiner, in bags, carloads. Carloads, slabs loose, 0.4c less. Melting points are EMP (ASTM) methods; add 3° to convert into AMP.)

Fully refined:		
122-124 (bags only)	5.6	5.6
125-127	6	6
127-129	6.25	6.25
130-132	6.55	6.55
132-134	6.8	6.8
135-137	7.55	7.55

Petrolatums

WESTERN PENNA. (Bbls., carloads; tank cars, 0.5c per lb. less.)

Snow White	6.125- 7.25	6.125- 7.25
Lily White	5.375- 6.25	5.375- 6.25
Cream White	4.375- 5.5	4.375- 5.5
Light Amber	3.375- 4	3.375- 4
Amber	3.125- 3.75	3.125- 3.75
Red	3 - 3.5	3 - 3.5

Tank Wagon Prices

Commercial or consumer tank car, tank wagon, dealer, and service station prices for gasoline **do not include taxes;** *they do, however, include inspection fees as shown in general footnote. Gasoline taxes, shown in separate column, include 1.5c federal, and state taxes; also city and county taxes as indicated in footnotes. Kerosine tank wagon prices also do not include taxes; kerosine taxes where levied are indicated in footnotes. Dealer discounts are shown in footnotes. These prices in effect Feb. 5, 1945 as posted by principal marketing companies at their headquarters offices, but subject to later correction*

S. O. N. J. — Esso (*Regular Grade*)

	Consumer Tank Wagon	Dealer T.W.	Gasoline Taxes	Kerosine T.W.
*Atlantic City, N. J.	10.2	10.7	4.5	10
*Newark, N. J.	10.2	10.7	4.5	10
Annapolis, Md.	10.55	11.05	5.5	....
Baltimore, Md.	9.95	10.45	5.5	10.8
Cumberland, Md.	11.35	11.85	5.5	12.3
Washington, D. C.	10.2	10.7	4.5	11.3
Danville, Va.	11.65	12.15	6.5	12.55
Norfolk, Va.	10.45	10.95	6.5	12.3
Petersburg, Va.	10.75	11.25	6.5	13.3
Richmond, Va.	10.75	11.25	6.5	13.3
Roanoke, Va.	11.95	12.45*	6.5	12.8
Charleston, W. Va.	11.65	12.15*	6.5	13.1
Parkersburg, W. Va.	10.95	11.45	6.5	12.8
Wheeling, W. Va.	10.95	11.45*	6.5	13.4
Charlotte, N. C.	11.70	12.20*	7.5	11.3
Hickory, N. C.	12.25	12.75	7.5	12.3
Mt. Airy, N. C.	12.10	12.6	7.5	11.5
Raleigh, N. C.	11.45	11.95	7.5	12.3
Salisbury, N. C.	11.75	12.25	7.5	12.7
Charleston, S. C.	10.55	11.05	7.5	.....
Columbia, S. C.	11.40	11.9	7.5	.....
Spartanburg, S. C.	12.1	12.6	7.5	.....
New Orleans, La.	8.75	9.25	8.5	10.00
Baton Rouge	8.75	9.25	8.5	10.50
Alexandria	8.75	9.25	8.5	10.50
Lake Charles	9.00	9.50	8.5	12.00
Shreveport	8.50	9.00	8.5	9.00
Knoxville, Tenn.	10.50	11.00	8.5	12.50
Memphis	8.90	9.40	8.5	10.50
Chattanooga	10.50	11.00	8.5	11.00
Nashville	10.50	11.00	8.5	10.00
Bristol	10.95	11.45	8.5	13.10
Little Rock, Ark.	9.50	10.00	8.0	10.00

	Mineral Spirits T.W.	V.M.&P. T.W.
Newark, N. J.	13	14.5
Baltimore, Md.	15.5	....
Washington, D. C.	15.5	....

Fuel Oils—T.W.	No. 1	No. 2	No. 3
Atlantic City, N. J.	10	9	9
Newark	10	9	9
Annapolis, Md.	..	..	..
Baltimore	9.8	9	9
Washington, D. C.	10.3	9.4	9.4
Norfolk, Va.	10	8.8	8.8
Petersburg	10.3	9	..
Richmond	10.3	9	9
Charlotte, N. C.	10.3	10.1	..
Hickory, N. C.	..	9.7	..
Raleigh	11.3	9.8	..
Charleston, S. C.	..	8.7	..
Columbia	..	9.7	..
Spartanburg	..	10.5	..

*Effective Aug. 5, '42 minimum retail resale price of 14.2c posted thru New Jersey.

Discounts:

Esso gasoline—to undivided dealers, 0.5c off dealer t.w.

Kerosine—1c off t.w. price for 25 gals. or more, under contract thru territory (Baltimore city contract not necessary) except no discount in state of New Jersey.

Naphtha—To buyers taking following quantities at one time: Newark, 2c per gal. on 200 gals. or more, less than 200 gals. 0.5c higher price; Baltimore, 2c off on 25 to 100 gals. and 3c on over 100 gals.; Washington, 2c off to contract buyers.

Notice

These prices include inspection fees on both gasoline and kerosine unless otherwise specified per gallon as follows:

Ala. 1/40c on gasoline; Ark. 1/20c; Fl. 1/8c; Ill. 3/100c; Ind. 1/5c in lots of 25 bbls. or less, 2/25c in lots of more than 25 bbls.; Kans. 1/50c; La. 1/32c; Minn. 7/200c; Miss. 1/50c; Neb. 3/100c; Nev. 1/20c; N. C. 1/4c; N. Da. 1/20c; Okla. 2/25c; S. Car. 1/8c; S. Da. 1/20c; Tenn. 2/5c; and Wisc. 3/100c.

Kerosine inspection fees only: Ala. 1/2c; Fla. 1/8c; Iowa 3/50c; Mich. 1/5c per gal.

CONT'L OIL

†Tank	Conoco Bronz-e-z Wagon	Demand (*3rd Grade*)	Gasoline Taxes	Kerosine T.W.
Denver, Col.	10	9	5.5	10
Grand Junc., Col.	12.5	11.5	5.5	12.8
Pueblo, Col.	9.5	8.5	5.5	9.8
Casper, Wyo.	11.5	10.5	5.5	12
Cheyenne, Wyo.	10	9	5.5	9
Billings, Mont.	12	11	6.5	12.8
Butte, Mont.	11.5	10.5	6.5	13.5
Great Falls, Mont.	12	11	6.5	12.5
Helena, Mont.	12	11	6.5	13
Salt Lake City, Utah	13.5	12.5	5.5	14.5
Boise, Ida.	13.6	12.6	6.5	16.5
Twin Falls, Ida.	14.6	13.6	6.5	17
Albuquerque, N. M.	10.5	9.5	*7	9.8
Roswell, N. M.	10	9	*7	7
Santa Fe, N. M.	10.5	9.5	*7.5	10
Ft. Smith, Ark.	9	6.25	*7	8
Texarkana, Ark.	9	7.5	*5.5	7
Muskogee, Okla.	7.75	6.75	7	8
Oklahoma City, Okla.	8	7	7	8
Tulsa, Okla.	8	7	7	8

*Taxes: In gasoline tax column are included these city taxes—Albuquerque, & Roswell, 0.5c, Santa Fe, 1c. Texas 4c state tax applies within city limits of Texarkana, Ark.; Okla., 5.5c state applies within city limits of Ft. Smith, Ark.

†To Consumers & Dealers.

NOTE: Current selling price—where this is lower than maximum price it is because of local competition. It is the actual selling price and is subject to revision due to delays in receiving information from the field.

S. O. CAL.

Standard Gasoline (*Regular Grade*)
Flight Gasoline (*Third Grade*)

	Standard Posted Net Tank Truck	Standard Posted Retail	Flight Posted Net Tank Truck	Flight Posted Retail	Gasoline Taxes
San Francisco, Cal.	10	14	9	12	4.5
Los Angeles, Cal.	9.5	13.5	8.5	11.5	4.5
Fresno, Cal.	11	15	10	13	4.5
Phoenix, Ariz.	12	16	10	13	6.5
Reno, Nev.	12	16	11	14	5.5
Portland, Ore.	10.5	14.5	9.5	12.5	6.5
Seattle, Wash.	10.5	14.5	9.5	12.5	6.5
Spokane, Wash.	12.5	16.5	11.5	14.5	6.5
Tacoma, Wash.	10.5	14.5	9.5	12.5	6.5

Std. Aviation 73

	Posted Net Tank Truck	Gasoline Taxes	Kerosine Tank Truck
San Francisco, Cal.	12.5	4.5	11.5
Los Angeles, Cal.	12	4.5	10
Fresno, Cal.	13.5	4.5	12.5
Phoenix, Ariz.	14.5	6.5	12.5
Reno, Nev.	14.5	5.5	13.5
Portland, Ore.	13	6.5	13.8
Seattle, Wash.	13	6.5	13.8
Spokane, Wash.	16	6.5	16.8
Tacoma, Wash.	13	6.5	13.8

Resale and Commercial Gasoline: Tank car deliveries of Standard Aviation 73, Standard's Supreme and Flight Gasoline .25c per gal. below posted net tank truck price. Tank car deliveries of Standard Gasoline .375c per gal. below posted net tank truck price. Pearl Oil (The Standard Kerosene) Tank car deliveries 3c below posted tank truck price.

TEXAS CO.

	Gasoline—Dealer T.W. Fire-Chief (*Regular*)	Indian (*3rd Grade*)	Gasoline Taxes
Dallas, Tex.	7.5	6.5	5.5
Ft. Worth, Tex.	7.5	6.5	5.5
Wichita Falls, Tex.	8.5	7.5	5.5
Amarillo, Tex.	8.5	7.5	5.5
Tyler, Tex.	8.5	7.5	5.5
El Paso, Tex.	11	10.5	5.5
San Angelo, Tex.	8.5	7.5	5.5
Waco, Tex.	8.5*	7*	5.5
Austin, Tex.	8.5	7.5	5.5
Houston, Tex.	8.5	7.5	5.5
San Antonio, Tex.	8.5	7.5	5.5
Port Arthur, Tex.	8.5	7.5	5.5

*Less 1c temporary allowance to all dealers.

(Continued on next page)

Tank Wagon Prices—Continued

S. O. IND.

Red Crown (*Regular Grade*)
Blue Crown (*Third Grade*)
Red Dealer Prices

	Crown Cons. T.W.	Red Crown	Blue Crown	Gasoline Taxes	Kerosine T.W.
Chicago, Ill.	11.6	9.6	9.1	4.5	10.6
Decatur, Ill.	11.6	9.6	8.7	4.5	10.3
Joliet, Ill.	11.9	10.3	9.2	4.5	10.6
Peoria, Ill.	11.7	9.9	9.7	4.5	10.4
Indianapolis, Ind.	11.6	10.1	9.6	5.5	10.1
Evansville, Ind.	11.4	9.9	8.6	5.5	9.9
South Bend, Ind.	12	10.5	10	5.5	10.5
Detroit, Mich.	11.4	9.9	....	4.5	10
Grand Rapids, Mich.	11.4	9.9	....	4.5	9.9
Saginaw, Mich.	11.4	9.9	....	4.5	9.9
Green Bay, Wis.	12.2	10.7	10.2	5.5	10.9
Milwaukee, Wis.	12.1	10.6	10.1	5.5	10.8
La Crosse, Wis.	11.9	10.4	9.9	5.5	10.6
Minneapolis - St. Paul.	11.9	10.4	9.9	5.5	10.6
Duluth, Minn.	12.2	10.7	10.2	5.5	10.9
Mankato, Minn.	11.9	10.4	9.9	5.5	10.6
Des Moines, Ia.	11.4	9.9	9.4	4.5	*10.1
Mason City, Ia.	11.7	10.2	9.7	4.5	*10.4
St. Louis, Mo.	11.0	9.5	9.3	*4.5	10.1
Kansas City, Mo.	11.0	9.5	8.6	*4.5	9.7
St. Joseph, Mo.	11.2	9.7	9.2	*4.5	9.9
Fargo, N. D.	12.9	11.4	10.9	5.5	11.6
Huron, S. D.	12.3	10.8	10.3	5.5	11
Wichita, Kans.	10.3	8.8	7.2	4.5	9.0
Omaha, Neb.	11.4	9.6	9.4	6.5	10.1

	Oleum Spirits	V.M.&P. Naphtha	Stanisol	*Taxes
(Prices are base prices before discounts)				
Chicago	13.5	13.8	12.8	4.5
Detroit	15.8	15	16.3	4.5
K. C., Mo.	13.3	14.3	13.8	1.5
St. Louis, Mo.	13.7	14.7	13.2	1.5
Milwaukee	14.4	15.4	14.9	5.5
Minneap'ls	14.2	15.2	13 5	5.5

Fuel Oils T.W.
Chicago

	Standard Heater Oil	Stanolex Furnace Oil
1-99 gals.	9.3	8.8
100-149 gals.	8.3	7.8
150 gals. & over	7.8	...
150-399 gals.	...	7.8
400 gals. & over	...	7.3

	Stanolex Fuel A	Stanolex Fuel C
1-749 gals.	6.5	6.0
750 gals. & over	5.75	5.25

Stanolex Furnace Oil

Other Points	1-99 gals.	100 gals. & over
Indianapolis	9.0	8.0
Detroit	8.7	7.7
Milwaukee	9.0	8.0
Minneapolis	9.1	8.1
St. Louis	8.4	7.4
Kansas City	8.1	7.1

*Taxes: In gasoline tax column are included these city taxes—Kansas City, St. Joseph and St. Louis, 1c. Iowa kerosine prices are ex 3c state tax. In naphtha tax column are included 1.5c federal tax and state taxes.

State sales, occupation, consumer and use taxes to be added when applicable.

S. O. OHIO

*Sohio X-70 Gasoline (*Regular Grade*)

	Consumer T.W.	**Reselers	‡S.S.	Gasoline Taxes	†Kerosine T.W.
Ohio, Statewide..	12	10	13.5	5.5	9.3
Akron	12	9.5	12.5	5.5	9.3
Canton	12	9.5	12.5	5.5	9.3
Cincinnati	12	9.5	12.5	5.5	9.3
Cleveland	12	9.5	12.5	5.5	9.3
Columbus	12	9.5	12.5	5.5	9.3
Dayton	12	9.5	12.5	5.5	9.3
Lima	12	9.5	12.5	5.5	9.3
Mansfield	12	9.5	12.5	5.5	9.3
Marion	12	9.0	12.0	5.5	9.3
Portsmouth	12	9.5	12.5	5.5	9.3
Toledo	12	9.5	12.5	5.5	9.3
Youngstown	12	9.5	12.5	5.5	9.3
Zanesville	12	9.5	12.5	5.5	9.3

Aviation Gasoline—Statewide

	Consumer T.W.	Gasoline Taxes
Sohio Aviation Gasoline clear Spec. AN-F-22	14.5	5.5
Esso Ethyl Aviation 73 Oct.	15.5	5.5
Esso Ethyl Aviation 80 Oct.	16.5	5.5
Esso Ethyl Aviation 91 Oct.	17.5	5.5
Esso Ethyl Aviation 100 Oct.	24.5	5.5

	Naphtha—T.W. Statewide	Lucas County
S. R. Solvent	13.5	13.5
D. C. Naphtha	14.5	14.25
V.M.&P. Naphtha	14.5	14.25
Varnolene	14.5	14.25
Sohio Solvent	14.5	14.25

Fuel Oils—T.W.	No. 1	No. 2	No. 3	No. 4
Ohio, Statewide	8.3	8.3	7.8	*7.55

*Renown (third-grade) prices are same as X-70 unless otherwise noted.

**Except authorized agents.

‡Prices at company-operated stations.

††Statewide prices are subject to exceptions other than those shown.

Discounts:

Esso aviation—on contract to hangar operators and resellers, 2c off consumer t.w.

*For Cleveland area only. Full compartment hose dumps.

Fuel oils—Statewide prices are for t.w. & drum deliveries of 50 gals. or more; prices for deliveries of less than 50 gals. are 0.5c higher.

Naphthas—to contract consumers off t.w. prices—Statewide: 300 to 999 gals., 0.5c; 1000 to 2499 gals., 0.75c; 2500 to 4999 gals., 1c; 5000 or more gals., 1.5c. Lucas County: Less than 50 gals., tank wagon price, 50 to 249 gals., 0.5c; 250 to 499 gals., 1c; 500 gals. or over, 1.5c.

ATLANTIC REFINING

Atlantic White Flash (*Regular Grade*)

	Commercial T.W.	Dealer T.W.	Gasoline Taxes	Kerosine T.W.
Philadelphia, Pa.	10.2	10.7	5.5	12.25
Pittsburgh	10.1	10.6	5.5	12.1
Allentown	10.7	11.2	5.5	12.6
Erie	10.1	10.6	5.5	12.1
Scranton	10.7	11.2	5.5	12.6
Altoona	10.7	11.2	5.5	12.6
Emporium	10.1	10.6	5.5	12.1
Indiana	10.7	11.2	5.5	12.6
Uniontown	10.1	10.6	5.5	12.1
Harrisburg	10.7	11.2	5.5	12.6
Williamsport	10.7	11.2	5.5	12.6
Dover, Del.	....	11.2	5.5	12.6
Wilmington, Del.	....	10.7	5.5	12.1
Boston, Mass.	....	10.9	4.5	....
Springfield, Mass.	....	11.8	4.5	....
Worcester, Mass.	....	11.5	4.5	....
Fall River, Mass.	....	11	4.5	....
Hartford, Conn.	....	11.6	4.5	....
New Haven, Conn	....	11	4.5	....
Providence, R. I.	....	11	4.5	....
Atlantic City, N. J.	....	10.7	4.5	10
Camden, N. J.	....	10.7	4.5	10
Trenton, N. J.	....	10.7	4.5	10
Annapolis, Md.	....	11.05	5.5	10.8
Baltimore, Md.	....	10.45	5.5	9.8
Hagerstown, Md.	....	11.55	5.5	10.3
Richmond, Va.	....	11.25	6.5	12.3
Wilmington, N. C.	....	11.15	7.5	11.6
Brunswick, Ga.	....	10.1	7.5	10.6
Jacksonville, Fla.	....	10.1	8.5	11.6

	Mineral Spirits T.W.†	V.M.&P. T.W.†
Philadelphia, Pa.	11	12.5
Lancaster, Pa.	12	13.5
Pittsburgh, Pa.	12.5	13.5

Fuel Oils—T.W.	1	2	3	5	6
Phila., Pa.	10.1	9	9	5.76	5.04
Allentown, Pa.	10.6	9.3	9.3	....	...
Wilmington, Del.	10.1	9	9	....	...
Springfield, Mass.	10.2	9.4	9.4	....	...
Worcester, Mass.	10.2	9.3	9.3	....	...
Hartford, Conn.	10.5	9.2	9.2	....	...

‡Does not include 1c Georgia kerosine tax.
†Mineral Spirits prices also apply to Stoddard Solvent; V.M.&P. prices also apply to Light Cleaners Naphtha.
Discounts:
Gasoline—to undivided dealers, 0.5c off dealer t.w. except Georgia & Florida dealer t.w and undivided dealer t.w. prices are same.
Kerosine—Thru Penna. & Delaware, 2c off t.w price on t.w. deliveries of 25 gals. or more at one time.

	Kerosine *Tank Wagon	Retail
Dallas, Tex.	7	10
Ft. Worth, Tex.	7	11
Houston, Tex.	8	11
San Antonio, Tex.	7	10

*To all classes of dealers & consumers

S. O. KY.

Crown Gasoline (*Regular*)
Standard (*Third Grade*)

	†Net Crown	Gasoline Taxes	Kerosine T.W.
Covington, Ky.	9.5	6.5	9.8
Lexington, Ky.	10.5	6.5	9.8
Louisville, Ky.	10	6.5	8.8
Paducah, Ky.	10	6.5	8.8
Jackson, Miss.	10	7.5	*9
Vicksburg, Miss.	9.5	7.5	*8.5
Birmingham, Ala.	10	*8.5	9
Mobile, Ala.	9	*9.5	8.5
Montgomery, Ala.	10	*9.5	*10
Atlanta, Ga.	11.1	7.5	*11.6
Augusta, Ga.	11.1	7.5	*11.1
Macon, Ga.	11.1	7.5	*11.6
Savannah, Ga.	10.1	7.5	*10.6
Jacksonville, Fla.	10.1	8.5	9.6
Miami, Fla.	10.1	8.5	9.6
Pensacola, Fla.	9	*9.5	8
Tampa, Fla.	10.1	8.5	9.6

*Taxes: In tax column are included these city and county gasoline taxes: Mobile, 2c city; Birmingham, 1c city, Montgomery, 1c city and 1c county; Pensacola, 1c city. Georgia and Montgomery, Ala. have 1c kerosine tax, Mississippi 0.5c, included in above prices.

†Consumer t.w. prices are same as net dealer prices.

HUMBLE OIL

Humble Motor Fuel (*Regular Grade*)

	Thriftane Humble *Tank Wagon	Re-tail	(*Third Grade*) Thriftane *Tank Wagon	Re-tail	Gasoline Taxes
Dallas, Tex.	7.5	10.5	6.5	10.5	5.5
Ft. Worth, Tex.	6.5	9.5	6	7.5	5.5
Houston, Tex.	8.5	12.5	7.5	10.5	5.5
San Ant., Tex.	8.5	12.5	7.5	10.5	5.5

Consumer tank wagon prices are 1c per gal. above the dealer tank wagon prices at Dallas and Ft. Worth.

Canada

PRICES OF IMPERIAL OIL, LTD.

Per Imperial Gallon, which is 1.2 U. S. Gallons

IMPERIAL OIL

3-Star Imperial Gasoline (*Regular Grade*)

	†Gasoline T.W.	*Gasoline Taxes	Kerosine T.W.
Hamilton, Ont.	16.5	11	18
Toronto, Ont.	16.5	11	18
Brandon, Man.	20.5	10	23
Winnipeg, Man.	20.0	10	22.5
Regina, Sask.	17.5	10	20
Saskatoon, Sask.	20.3	10	22.8
Edmonton, Alta.	18.4	10	20.9
Calgary, Alta.	15.5	10	18
Vancouver, B. C.	15	10	24
Montreal, Que.	16.5	11	17.5
St. John, N. B.	16	13	19
Halifax, N. S.	16	13	19

*Includes 3c Federal, and Provincial taxes.
†To divided & undivided dealers
Absorption Gasoline—No. 26 R V.P.—$2.28
Gasoline prices effective Oct. 7

SOCONY VACUUM

Socony Mobilgas (*Regular Grade*)

	Com. Cons. T.W.	Undiv. Dlr. T.W.	Gasoline Taxes
New York City			
Manhattan & Bronx	10.1	10.6	*5.5
Kings & Queens	10.1	10.6	*5.5
Richmond	9.7	10.2	*5.5
Albany, N. Y.	9.9	10.4	5.5
Binghamton, N. Y.	11	11.5	5.5
Buffalo	9.6	10.1	5.5
Jamestown, N. Y.	9.8	10.3	5.5
Mt. Vernon, N. Y.	10.1	10.6	5.5
Plattsburg, N. Y.	11	11.5	5.5
Rochester, N. Y.	10.8	11.3	5.5
Syracuse, N. Y.	10.5	11	5.5
Bridgeport, Conn.	10	10.5	4.5
Danbury, Conn.	10.5	11	4.5
Hartford, Conn.	10.6	11.1	4.5
New Haven, Conn.	10	10.5	4
Bangor, Me.	10.7	11.2	5.5
Portland, Me.	10.3	10.8	5.5
Boston, Mass.	9.9	10.4	4.5
Concord, N. H.	11.4	11.9	5.5
Lancaster, N. H.	12	12.5	5.5
Manchester, N. H.	11.3	11.8	5.5
Providence, R. I.	10	10.5	4.5
Burlington, Vt.	10.9	11.4	5.5
Rutland, Vt.	11	11.5	5.5

(Continued on next page)

Seaboard Export Coastwise Prices

Atlantic Coast

(Prices are of refiners, FOB their refineries & their tanker terminals, & of tanker terminal operators FOB their terminals)—Prices in Effect Feb. 5.

MOTOR GASOLINE

District	72 Oct. (ASTM)	70-74 oct. (ASTM)
N. Y. Harb.	Not made	9.075
N. Y. Harb., barges	"	8.975
Albany	"	9.175
Philadelphia	"	9.075
Baltimore	"	8.825
Norfolk	"	8.575
Wilmington, N. C.	"	8.175
Charleston	"	8.175
Savannah	"	7.845
Jacksonville	"	7.845
Miami	"	7.845
Tampa	"	7.845
Pensacola	"	6.875 (1)
Mobile	"	6.62 – 6.745
New Orleans	"	6.125(1)
Portland	"	9.375
Boston	"	9.275
Providence	"	9.275

FUEL OILS

District	KEROSINE and/or NO. 1 FUEL	No. 2	No. 3	No. 5	No. 6
N. Y. Harb.	7.1	6.7	6.7	$1.85–$1.95 (a)	$1.77
N. Y. Harb., barges	7	6.6	6.6	....	....
Albany	7.3	6.8	6.8 (2)	....	$1.97 (1)
Philadelphia	7.2	6.7	6.7	$1.98	$1.77
Baltimore	7.2	6.7	6.7	$1.85 (1)	$1.77
Norfolk	7.1	6.7	6.7 (1)	$1.85 (1)	$1.77
Wilmington, N. C.	6.75	6.4	....	....	....
Charleston	6.9	6.4 (2)	....	$1.80 (1)	$1.72 (2)
Savannah	6.55	5.75 (1)	....	....	$1.72 (1)
Jacksonville	6.55	5.75	....	....	$1.72
Miami	6.55	5.75 (1)	....	....	....
Tampa	6.55	5.75	....	....	$1.62
Pensacola	4.8 (1)	....	....	....	....
Mobile	4.75 (2)	....	....	....	....
New Orleans	4.125–4.25 (2)	3.75 (2)	....	$1.27 (1)	$0.97
Portland	7.3	6.8	6.8 (2)	....	$1.77
Boston	7.2	6.7	6.7 (2)	$1.95 (2)	$1.77
Providence	7.2	6.7	6.7 (2)	$1.90 (1)	$1.77

(a) Price is for straight-run low pour, test No. 5 ($1.95)

Pacific Export

In Ship's Bunkers, or deep tank lots:

Prices in Effect	Feb. 5	Jan. 29
Diesel Fuel, Pac. Spec. 200	$1.45	$1.45
Grade C fuel, Pac. Spec. 400	$1.10	$1.10

Tank Wagon Prices (Continued)

	Mineral Spirits T.W.	V.M.&P. T.W.
Buffalo, N. Y.	12.4	13.6
New York City	11	12
Rochester, N. Y.	13.2	14.4
Syracuse, N. Y.	14	....
Boston, Mass.	12	13
Bridgeport, Conn.	†16.3	†17.3
Hartford, Conn.	†16.3	†17.3
Providence, R. I.	13	14

	Kerosine Yard	Kerosine T.W.	Mobilfuel Diesel T.C.	Mobilfuel Diesel T.W	Mobilheat Fuel Yard	Mobilheat Fuel T.W.
New York:						
Manhat'n & Bronx	7.5	10.3	...	9.3	7.1	9
Kings & Queens	7.5	10.3	...	9.3	7.1	9
Richmond	7.5	10.3	...	...	7.1	9.0
Albany	7.5	9.8	6.8	9.3	7	9
Binghamton	8.9	11.2	...	10.7	8.4	10.2
Buffalo	8.1	10.4	7.5	9.8	7.7	9.5
Jamestown	8.2	10.5	...	10.1	7.8	9.5
Mt. Vernon	7.6	10.3	...	9.4	7.2	9
Plattsburg	8.1	10.4	...	9.9	7.6	9.4
Rochester	8.7	11	7.9	10.2	7.9	9.7
Syracuse	8.5	10.8	7.8	10.1	7.8	9.6
Conn.:						
Bridgeport	7.8	10.3	...	....	7.3	9.0
Danbury	8.2	10.8	...	....	7.8	8.5
Hartford	8.0	10.5	...	9.5	7.4	9.2
New Haven	7.5	10.3	...	9.3	7.1	9.0
Maine:						
Bangor	7.9	10.2	7.4	9.7	7.4	9.1
Portland	7.5	10.2	6.8	9.3	7	9
Mass.:						
Boston	7.8	10.6	6.7	9.2	7.1	9
N. H.:						
Concord	8.4	10.7	...	....	8.2	10
Lancaster	9.5	11.8	...	....	9.2	11
Manchester	8.5	11.1	...	....	7.9	9.7
R. I.:						
Providence	7.8	10.1	6.7	9.2	7.1	9.0
Vermont:						
Burlington	8.1	10.4	7.5	9.8	7.5	9.2
Rutland	8.3	10.6	...	10	7.7	9.5

*Does not include 1% city sales tax applicable to price of gasoline (ex tax).

†In steel barrels.

Discounts: Diesel—On t.w. deliveries, 0.5c for at least 400 gals.; 1c for full tank truck.

EXPORT PRICES

Prices Effective Feb. 5

	Mexican Gulf Ports U. S. Dollars per Bbl. Bunker C	Diesel
Tampico	$0.97	$1.65
Veracruz	0.97	....
Coatzacoalcos	0.97	1.65
Pacific Coast		
Guaymas	$1.50	$3.22
Mazatlan	1.50	3.22
Acapulco	1.50	2.89
Manzanillo	1.50	2.89
Salina Cruz	1.50	2.89

	Bunker C Fuel Ships' bunkers (Ex Lighterage)	Diesel Oil Ships' bunkers (Ex Lighterage)	Diesel Oil Shore Plants	Gas House Gas Oil 28-34 Gravity
New Haven	$1.77	....	....	....
N. Y. Harbor	$1.77	$2.78	6.7	6.8 (2)
Albany	$1.97 (1)	$2.94 (1)	6.8 (1)	7 (1)
Philadelphia	$1.77	$2.78	....	....
Baltimore	$1.77	$2.78	6.7 (1)	6.7 (1)
Norfolk	$1.77	$2.78	6.7 (1)	6.7 (1)
Charleston	$1.72 (2)	$2.65 (1)	6.4 (1)	6.4 (1)
Savannah	$1.72 (1)	$2.52 (1)	....	....
Jacksonville	$1.72	$2.41 (2)	....	....
Tampa	$1.62	$2.41 (2)	....	....
New Orleans	$0.97	$1.65 (1)	4 (1)	....
Portland	$1.77	....	6.8 (1)	6.9 (1)
Boston	$1.77	$2.78	6.7 (2)	6.8 (2)
Providence	$1.77	$2.78 (2)	6.7 (1)	6.8 (1)

Bunker "C" when from Navy storage at New York and Norfolk to out-going vessels ships .05c discount. (Subject to cancellation.)

Gulf Coast

Prices in Effect Feb. 5

MOTOR GASOLINE	New Orleans & Lower Mississippi to Baton Rouge Tank Cars	New Orleans & Lower Mississippi to Baton Rouge Barges	Texas Gulf Coast South of New Orleans Tank Cars	Texas Gulf Coast South of New Orleans Barges	CARGOES Domestic & Export From all Gulf Ports
Leaded (oct. by ASTM)					
76 oct.	6.75	6.5	6.75	6.75	6.75
70-74 oct.	6 – 6.125	5.625	5.625–6.375 (a)	5.625	5.625
63-65 oct.	....	....	....	....	....
Unleaded 70 oct.	....	....	....	....	5.625
67-68 oct.	....	....	....	....	....
65 oct.	....	....	....	....	5.25
60 oct.	....	....	....	....	5
KEROSINE & LIGHT FUELS					
41-43 w.w. kero.	4.125– 4.25	4.125	4.125– 4.25	4.125	4.125
42-44 w.w. kero.	....	....	4.125	4.125	4.125
No. 2 fuel oil	3.75	3.75	3.75 – 4	3.75	3.75
DIESEL & GAS OILS					
(In diesel index No.)					
Below 43 di.	....	....	....	....	....
43-47 di.	....	....	....	....	4
48-52 di.	4	4	4	....	4
53-57 di.	4.125	....	4.125	4.125	4.125
58 and above	4.25	....	4.25	....	4.25

(a) 5.625c for Dist. 1 and 6.125–6.375c for other districts.

NOTE: Above products in Truck Transports of 2,400 gal. and over ½c above Tank Car Prices.

Heavy Fuels & Bunker Oil (at all Gulf Ports) Heavy Diesels	In Cargoes	In Ship's Bunkers (Ex Lighterage)
Below 28 API Grav.	....	$1.35
28 & above API Grav.	....	$1.65
Bunker C Oil	$0.97	$0.97

Mid-Continent Lubes

(At Gulf; in packages, FAS.; in bulk, FOB terminals).

Prices in Effect Feb. 5

	Steel Drums	Bulk
Bright Stock		
D color, Vis at 210°		
200 vis.	....	....
150 vis., 0-10 p.p.	32.65 (1&a)	24.8 (1)
100 vis., 0-10 p.p.	....	....
100 vis., 10-25 p.p.	....	....
Neutral—No. 3 color		
200 vis., 0-10 p.p.	....	— —

(A) FAS at New Orleans.

Wax

(Melting points are AMP, 3° higher than EMP. Prices are FOB refinery and do not include bag; freight or export differentials).

Prices in Effect Feb. 5

Crude Scale	New Orleans Export	N. Y. Domestic	N. Y. Export
124-6 Yellow	4.25(1)	....	4.25(1)
122-4 White	....	4.25(2)	4.25(2)
124-6 White	4.25(1)	4.25	4.25
Fully Refined:			
123-5	5.2(1)	5.2(2)	5.2(1)
125-7	5.2(1)	5.2(2)	5.2(1)
128-30	5.6(1)	5.6	5.6(1)
130-32	5.85(1)	5.85(2)	5.85(1)
133-5	6.15(1)	6.15	6.15(1)
135-7	6.4(1)	6.4(1)	6.4(1)

Naphtha

Prices in Effect Feb. 5

	V.M.&P. Naphtha	Mineral Spirits
New York Harbor	11 (2)	10
Philadelphia	11 (2)	10
Baltimore	10.5 (2)	9.5
Boston	11.5 (2)	10.5
Providence	11.5 (1)	10.5 (2)

CLASSIFIED

For Sale

FOR SALE: Two fully equipped and operating Service Stations and one Bulk Plant, consisting of four twenty thousand gallon tanks, pump and all facilities for tank car or transport deliveries. Bulk Plant and one Station on U. S. Highway in Eastern Pennsylvania Industrial City. Other station in heart of same city. Good steady gallonage. Box No. 518.

FOR SALE: Six pump completely equipped Filling Station (no grease or wash bay), on one acre of ground, located at the West City Limits of Bronson, Mich. For further information contact E. Lee Brown, Union City, Mich.

FOR SALE

1—Fruehauf Tandem Axle semi 3-compartment Tank Trailer, 4150 gallon, with eight 25 x 20 tires.
2—Gasoline Meter Registers, maximum capacity 2,000 gallons each.

Empire Equipment Corporation
608 Empire Bldg., Cleveland 14, Ohio
Phone: Main 7667

FOR SALE

1—1936 Studebaker truck with 750 gallon 3-compartment tank. Equipped with Brodie meter, Blackmer pump, hose and reel. All in excellent condition. Price $800.00.

McCleary Oil Company
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New and Reconditioned
IRON and STEEL
VALVES
Tested and Guaranteed
Also Fittings
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TRACTORS—HEAVY DUTY

Heavy duty Auto Car—Macks—Whites. Conventional and cab-over-engine, rebuilt and guaranteed, ready for immediate service upon delivery. Call, write, or wire—

Sam Cohen,
Cohen Equipment Co.,
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'Phone: Madison 5300

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10—Tandem Axle Tank Trailers from 4500 to 5100 gallon capacity, completely rebuilt and guaranteed, airbrakes, 3 inch lines, 2 and 3 compartments. Rebuilt and guaranteed, ready for immediate service upon delivery. Call, write or wire—

Sam Cohen,
Cohen Equipment Co.,
1918 Pingree, Detroit 6, Mich.
'Phone: Madison 5300

DIESEL TRACTORS

2—Auto Car Diesels, one cab-over-engine, one conventional. Both like new. With Cummins 150 HP Diesels, 1020 tires, airbrakes, rebuilt and guaranteed, ready for immediate service upon delivery. Price only $5750. Call, write or wire—

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RAILWAY TANK CARS

40—8000 Gallon Class II Gasoline Tank Cars NOW engaged in INTERSTATE Gasoline TRANSPORTATION. All cars conform to ICC and RR Regulations. Owner going out of business, therefore, offering these cars at the bargain price of **$1900.00** each, F.O.T. midwest area.

Immediate Delivery on **10** or **15,** balance in thirty days or sooner. IF INTERESTED please call, write or wire,

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SALES REPRESENTATION AVAILABLE: Manufacturer's agent wishes to add one or two equipment items to present line selling to oil marketers, refineries, chemical plants and industrial users. Good coverage in New York City, New Jersey and Philadelphia areas. Box No. 529.

GREASES

Manufacturer of grease has capacity for taking on extra grease business. Will manufacture standard greases or greases to specifications at attractive prices.

Box No. 528

Positions Wanted

REFINERY SUPERINTENDENT OR MANAGER: Forty years old. Nineteen years experience with modern equipment, including manufacture of 100 Octane Aviation gasoline. Box No. 530.

WANTED: Position by man with 20 years experience in refining and terminal supervision. Also 19 years in sales and application of industrial oils and greases, in both large and small industrial plants, as well as automotive equipment. Box No. 517.

Situations Open

SALESMAN-MANAGER WANTED: Old established company with nationally known gasoline and oil distributing franchise needs young man, over draft age, or draft exempt, to manage company operations in eastern city branch. Give experience, references and salary expected. All correspondence strictly confidential. Box No. 525.

OPPORTUNITY

Independent New York company has opening for aggressive young oil man (about 40) with knowledge of lubricating oils, petroleum specialties and export. Good present position. Excellent future possibilities.

Box No. 526

UNUSUAL OPPORTUNITY

For right man to take over management of long established lubricants business. Plant advantageously located in New York City. Sales ability required. Ex-service man with previous experience preferred.

Box No. 527

FIELD SUPERVISOR

Midwest compounder of premium grade automotive and industrial lubricants, marketing from Mississippi River to East coast and North of Tennessee, has opening for mechanical or chemical engineer with extensive application experience in all phases of lubrication, plus ability to supervise the sales and field activity of others.

Applicant should be 30 to 45 years of age, draft exempt, and have previous supervisory experience, preferably with an independent company specializing in industrial products. Permanent position with excellent future and good salary. Give full details first letter. Reply

BOX NO. 524

CLASSIFIED

Wanted to Buy

TANKS WANTED

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Copy must reach us not later than Saturday preceding date of issue.

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Tank Car Hauls to East Gain 15,474 b/d

NPN News Bureau

WASHINGTON—Tank car hauls to Dist. 1 averaged 471,419 b/d for the week ending Jan. 27, up 15,474 b/d from the low of the previous week, PAW announced. Shipments by companies were as follows:

Aetna	1	Elk Refining	35	Richfield	76
Allied	38	Freedom Oil	2	Roosevelt Oil	1
Amsco	115	Globe	154	Root	54
Arkansas Fuel	96	Gulf	1,473	Royal Petroleum	33
Ashland Refining	219	Hartol	106	Shell	679
Asiatic Petroleum	5	Hess, Inc.	10	Sinclair	655
Atlantic Refining	423	Home Oil	30	Socony-Vacuum	1,611
James B. Berry Sons	1	Jenny Mfg. Co.	15	Southland	7
Cantelou	24	Libby	2	Southport	25
Chalmette	10	Maritime Oil	60	S. O. California	1
Champlin	73	Mid-Continent	95	S. O. Indiana	701
Cities Service (Pa.)	298	National Refining	19	S. O. Kentucky	91
Coastal	5	Ohio Oil	74	S. O. New Jersey	2,823
Continental	113	Pacific	44	S. O. Ohio	187
Cooperative Refg. G.I.F.	11	Pan American	707	Sterling	11
Cosden	62	Petrol	5	Sun	1,358
Crown Central	64	Petroleum Heat & Power	16	Talco	7
Danciger	112	Phillips	325	Taylor Refg.	35
Daugherty	22	Pioneer	2	Texaco	1,198
Deblois	1	Premier	4	Tide Water	62
Dornoil	2	Primrose	36	Tiona	3
Drake	13	Pure	816	Triangle	36
Eastern	137	Republic	277	White Fuel	20

OPA Makes Good on Resolve For Firm 10-Gal. Ration

NPN News Bureau

WASHINGTON—It became increasingly apparent this week that OPA and PAW will go to most any lengths to hold fuel oil coupon values to at least 10 gals. per unit, in the face of one of the severest winters the U.S., and particularly the Northeast, has suffered in many years.

Over the week-end, and upon the recommendation of PAW, OPA announced that coupon values during Period 4 in the East, Midwest and Pacific Northwest, will remain at 10 gals. despite the fact that supplies in some areas are "very tight."

Instead of merely stating that values would remain as they are, OPA said that "no increase in coupon values" can be considered at this time "even though the weather has been unusually cold."

"Both agencies said that supplies in some sections—particularly in the eastern area—are very tight," the statement added.

"In spite of the abnormally cold weather, it is hoped that continuance of the 10-gallon value will enable householders to "get by" although in many homes this will mean that thermostats must be turned down still lower."

Period 4 begins Feb. 5, in the East and Pacific Northwest, and combined Periods 4 and 5 begin in the Midwest.

Earlier OPA had announced that fuel oil rations in North Carolina, South Carolina, Georgia and that part of Florida east of the Appalachicola River, will continue unchanged at 10 gals. per unit during the combined periods 4 and 5, which began Jan. 29.

Maintenance of the 10-gal. unit value was recommended by PAW.

Coming Meetings

FEBRUARY

Missouri Independent Oil Jobbers Assn., Governor Hotel, Jefferson City, Mo., Feb. 14-15.

MARCH

Illinois Petroleum Marketers Assn., Hotel Pere Marquette, Peoria, Ill., March 7-8. **(Postponed)**

APRIL

Independent Petroleum Assn., mid-year meeting of the Board of Directors, New Orleans, La., April 9-10-11.

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ABOUT OIL PEOPLE

Allan Johnston has been appointed manager of industrial sales for the United Gas Pipe Line Co. He succeeds **Harry E. Randall** who died last month.

In October, 1932, Mr. Johnston was employed by a predecessor company of United Gas Pipe Line Co., as industrial salesman, serving in that capacity successively in the Jackson, Dallas, Southwest Louisiana and Dallas-Shreveport districts.

° ° °

Mr. Wharton

Philip G. Wharton, general auditor of the Atlantic Refining Co. since 1935, has been elected vice president of the company, it was announced by **Robert H. Colley,** president.

Mr. Wharton has been with the company since 1911, serving for most of that period in the auditing department. He is a past president of the National Office Management Assn., a director of the American Management Assn., vice president of the Philadelphia chapter of Internal Auditors, Inc., and a member of the panel of arbitrators of the American Arbitration Assn.

J. P. Miller, Jr., has been named general auditor to succeed Mr. Wharton.

° ° °

W. H. Eddleman, veteran Wichita Falls, Tex., oil man, has been named assistant manager of the Fleming Oil Co. of Fort Worth.

° ° °

Fred Turner of Midland, Tex., independent oil operator, has purchased a 20,000-acre ranch in East Lea County, New Mexico, and has moved his thoroughbred horses there.

° ° °

William B. (Bill) Winckler, scout for the Magnolia Petroleum Co. in the Permian Basin region, has been moved to Colorado City, Tex., to work with **Frank H. Kelley,** land department manager in that district. He will be succeeded by **Henry B. Brock** of Wichita Falls.

° ° °

C. A. Young, secretary of the division of production of A.P.I., has announced that the institute's Board of Directors decided that the 25th annual meeting of the Institute would be held in Chicago in November 1945, if conditions permit.

The district spring meetings, at the suggestion of **D. T. Ring,** national chairman, has been cancelled in compliance with the request from the ODT.

° ° °

"Doing as nicely as can be expected" is the latest report on NPN's associate and technical editor, **V. B. Guthrie.** Mr. Guthrie is the proud grandfather, for the third time, a grandson having arrived at the home of his son, Bob, in Cleveland on Jan. 31.

° ° °

Lieut. Col. William B. Plummer, formerly aviation gasoline specialist of the Under Secretary of War's office and district chief of contract termination section, A.A.F. Eastern Procurement, New York, has been relieved from duty and has returned to industry with Standard of Indiana.

He first went with Standard in 1930 as chemical engineer to study the hydrogenation process, and when he joined the Armed Forces on Nov. 1, 1942, was manager of the development and patent department. He served as a second lieutenant of infantry in World War I.

° ° °

Dr. Minor C. K. Jones of the Esso Laboratories of Standard Oil Development Co. has been elected to the committee on membership of the Society of Sigma Xi, national scientific honor society. Founded at Cornell in 1886 for the encouragement of original scientific research, Sigma Xi has chapters and clubs in 125 colleges and universities.

° ° °

Col. Sadler Back in U. S.

Unshaven and tired from an ocean crossing, Lieut. Col. Gerald (Jerry) Sadler enjoys a cup of coffee upon his arrival at LaGuardia field, New York. Col. Sadler was a member of the Texas Railroad Commission before joining the Army as a private. He has been stationed in the Persian Gulf Command as a battalion commander in the Transportation Corps for 27 months, and expects to have a new assignment in the U.S. For his work in supplying goods of war to Russia via the overland route from Persia, he has been awarded the Order of the Fatherland for War, Russia's third highest decoration

Hugh L. Hemmingway, formerly with Kendall Refining Co. at Bradford, Pa., is now in the technical service department of the marketing division of Pure Oil Co., Chicago.

° ° °

H. B. Kirby, manager of the fuel oil department for Consumers Co., Chicago, announced removal of the general offices of the company from 111 West Washington St. to 228 N. LaSalle.

° ° °

George W. Hanneken, vice president in charge of manufacturing for Standard Oil Co. (Ohio) has announced that Dr. F. J. Sanders has been placed in charge of the company's No. 2 refinery in Cleveland.

Dr. Sanders

Dr. Sanders was formerly superintendent of Sohio's Toledo refinery and joined the company in 1934 to organize the Technical Service Group of the manufacturing department's process and development division. He headed Technical Service for five years, and in 1939 was placed in charge at Toledo.

Many processes having a major part in war production were installed under Dr. Sanders' direction while at the Toledo works. Included were alkylation, catalytic polymerization, cumene and dimer units, and a new delayed coking unit.

Dr. Sanders, a Texan, graduated with the degree of Chemical Engineer from Texas Technological Institute. He secured his doctorate in Chemical Engineering at Yale in 1933. He joined Standard after brief employment in the dye industry.

His transfer, Sohio says, will enable Dr. Sanders to bring his refining and technical experience and background to the development and manufacture of new lubricants. The No. 2 refinery is devoted exclusively to the manufacture of lubricating oils, greases and waxes.

° ° °

During the first six months of 1945, **William H. Tell,** assistant general manager of sales, and **Dr. M. G. Paulus,** vice president in charge of manufacturing at Standard of Indiana and 606 other employes will be awarded gold pins for 10 to 40 years of service. Five employes will receive 40-year pins, 74 will get 30-year pins, 348 will be given 20-year pins and 181 pins for 10 years of service. Mr. Tell is in the 40-year group and Dr. Paulus on the 30-year list.

M & S Service Record Speaks for Itself! . . .

As the owner of this M & S pump points out, that's a lot more trouble-free service from a pump than you would expect. But it is typical of hundreds of M & S pumps that have been hard at it for years. Their outstanding performance-record through these unusual times, when parts and replacements have not been available, is sound evidence of what precision-like workmanship and practical designing can do.

New M & S pumps for your busy service stations of tomorrow will start down the line as soon as conditions permit. They'll be even better mechanically than their pre-war cousins — they'll have many new and practical features to speed-up service and increase profits. If pumps are part of your post-war plans, write us now for complete information as soon as it is available.

LOOK TO M&S FOR THE PUMPS OF TOMORROW

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SALISBURY, MARYLAND

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..the Jobber Brand

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In our postwar planning program Fleet-Wing Corporation is taking steps to make sure that Fleet-Wing Jobbers and their dealers have available tested sales promotion and merchandising helps. We believe that Fleet-Wing will continue to be the "Fastest Selling Independent Brand in America".

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Write for this informative series of manuals about Fleet-Wing and the profit possibilities that are open for progressive Independent Jobbers and their Dealers.

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NATIONAL PETROLEUM NEWS

Monthly Technical Section Devoted to
REFINERY MANAGEMENT and PETROLEUM CHEMICAL TECHNOLOGY

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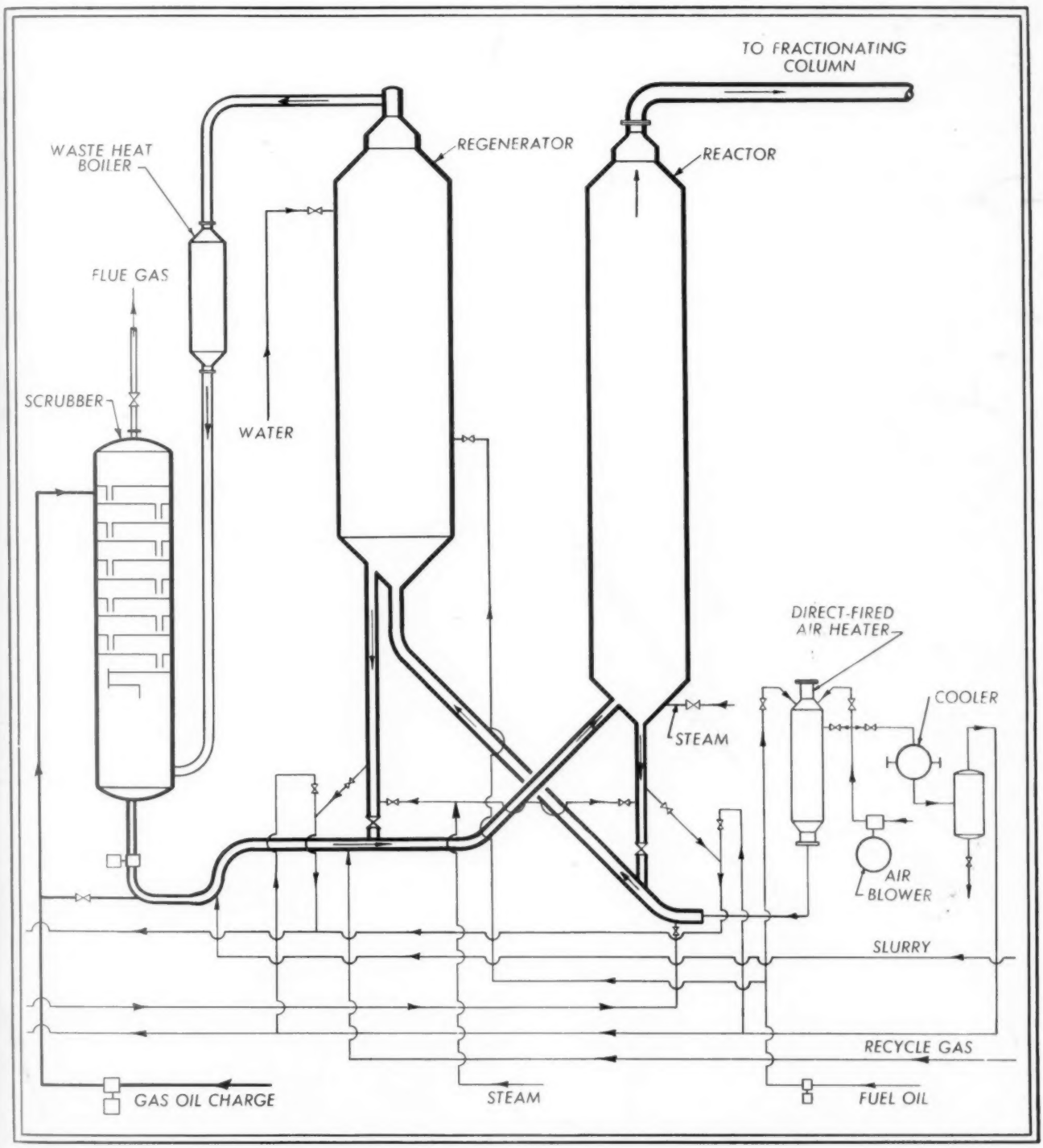
Section Two

February 7, 1945

2600 b/d Fluid Catalyst Unit



SUCCESSFUL OPERATION of a small capacity Fluid Catalyst unit has been achieved at the Frontier Refining Co.'s refinery at Cheyenne, Wyo. Charge capacity is 2600 b/d. The unit is of the single-stage type, but with several new design features incorporated, as shown in the above flow chart, to reduce fabrication costs. Overall height of the structure has been lowered by placing the regenerator on a level with the reactor, instead of above it as is done in larger units. Further cost reduction was achieved by using a specially designed scrubber for recovery of catalyst from the regenerator gases, eliminating the usual Cottrell precipitator. For full details, see page R-83.

Bridle Wild Horsepower

and curb lowering reservoir pressures

MAINTENANCE of Pressure on Oil Reservoirs Thru Gas Injection Will Usually:

1. **Increase Total Oil Recovery**
2. **Minimize Lifting Costs**

A properly designed and constructed pressure maintenance plant will, in many cases, provide a return on the investment greater than that received on any other invested capital in the field development.

Thru having designed and installed plants* now daily returning many hundreds of millions of feet of gas to producing reservoirs, Hudson is equipped, thru years of successful experience, to design and install complete facilities for pressure maintenance, including gathering systems, compressor plants, hydrocarbon extraction and fractionation units, dehydration plants, and dry gas injection piping systems.

*GAS COMPRESSOR STATIONS • CYCLING PLANTS • GAS DEHYDRATION PLANTS • NATURAL GASOLINE PLANTS • FRACTIONATION UNITS • HYDROGEN SULFIDE REMOVAL PLANTS • MECHANICAL AND NATURAL DRAFT COOLING TOWERS

HUDSON
ENGINEERING CORPORATION
Engineers and Constructors
FAIRVIEW STATION HOUSTON, TEXAS

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PREVIEW

Feature Articles Coming Next Month

Design Improvements Simplify Fluid Catalyst Process

This article describes the major engineering improvements which have been made in the design of the Fluid catalytic cracking process since it was first introduced into commercial operation. It compares the old "upflow" type of operation with the newer "downflow" type, explaining the advantages of the latter. The flow of operations through a typical fluid catalyst plant is described, and specific design features (instrumentation, valves, catalyst recovery) are gone into in detail.

Cutting Lag Between Research And Commercial Refining

The new laboratory facilities of one of the larger oil companies of the southwest include extensive pilot-plant scale equipment and other modern apparatus for the study of synthetic rubbers and the new petroleum products. The installation was designed and equipped to the end of shortening the period required for thorough research and development work in the field of the petroleum refining.

The facilities are described in a special article by an NPN Technical Section writer from a first hand visit and inspection of the laboratories.

Process Development Program

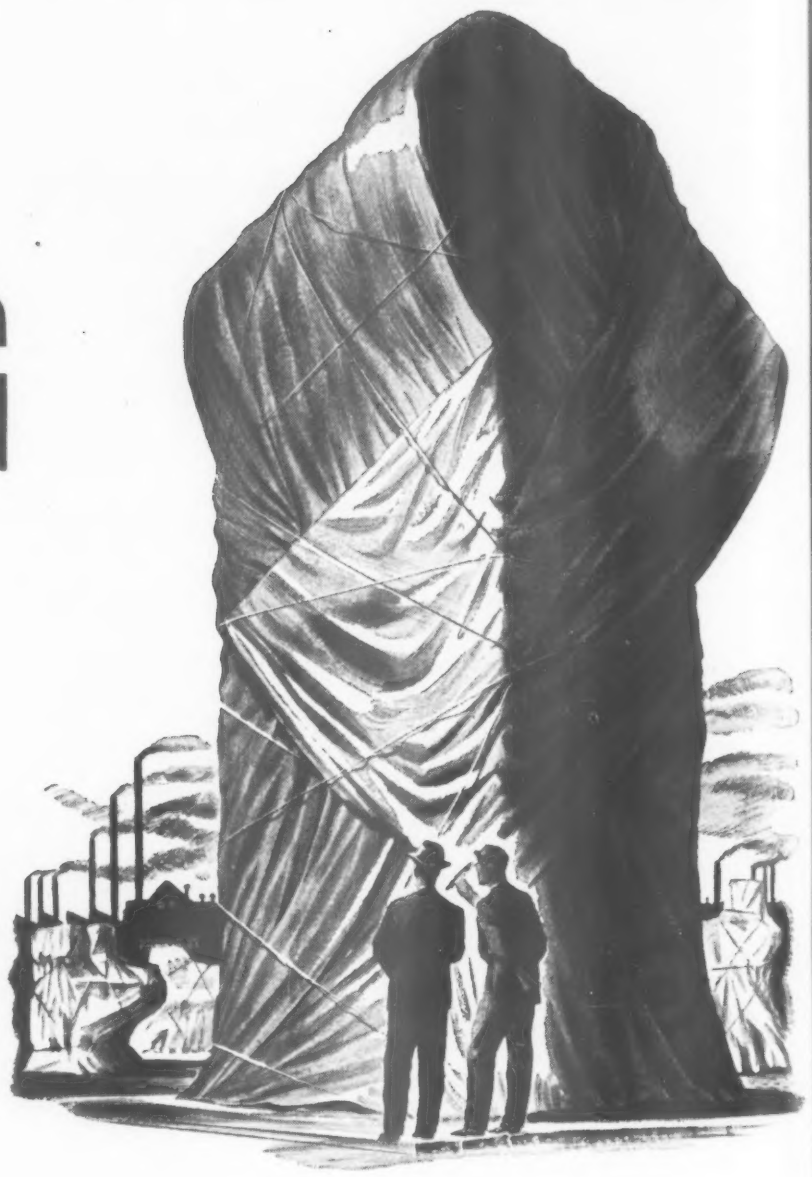
In view of the intricate nature of many of the modern refining processes, the systematic organization of the process development program is essential. A properly organized program is recognized as an increasingly important factor in achieving later successful commercial operations.

This article, by a representative of a large engineering firm, who is thoroughly familiar with process equipment, outlines six definite steps which he believes should be followed in sequence in the development of a new chemical process to minimize false moves and direct the work towards the desired goal. Although he discusses the subject in general terms, without reference to any specific process, the ideas he presents are equally applicable to a new refining operation.

Properties of Heating Oils From Catalytic Cracking

Physical characteristics of Houdry and T.C.C. distillate fuel oils from commercial operations have been studied in a number of ways to indicate their performance in pot-type as well as pressure and rotary-type burners. Results of this study are given in tables, graphs and photographs in a special article contributed by an important research organization.

THE SLEEPING GIANT



America's motorcar industry has been at war. When it gets back to making automobiles, a vast new opportunity for engine improvements will be waiting in the improved gasoline that will then be available.

HIGH ON THE LIST of things the average man wants after the war is a new automobile. But John Public looks forward to something more than just a *new* car—he wants a *better car*.

It is true that replacements for essential transportation may keep the automobile industry more than busy for quite awhile after the war. During this period revised versions of 1942 models may be all that are available. Once this phase of reconversion is over, there will be the problem of continuously rebuilding and replacing America's automobile population—and again the problems of "creating" sales and customers in a competitive market. We can look forward to future engineering competition along the lines of the simple, time-honored, American method of making better and better cars.

Refinements in body design, new accessories and greater riding comfort will play their part. But the most significant progress in motorcar design will depend—in the future, as in the past—*upon the development of engines that get more work from each gallon of gasoline.*

The basis for such progress already exists. It lies in the development of engines to fully utilize the greatly improved gasoline which the petroleum industry will be in a position to offer the public.

ETHYL CORPORATION

Chrysler Building, New York City

Manufacturer of Ethyl fluid, used by oil companies to improve the antiknock quality of aviation and motor gasoline.

Wartime progress by America's petroleum industry has paved the way for fundamental progress in post-war automobile engine design.

REFINERY MANAGEMENT *and*
PETROLEUM CHEMICAL TECHNOLOGY

Feb. 7, 1945
Volume 37
Number 6

MONTHLY TECHNICAL SECTION OF NATIONAL PETROLEUM NEWS *incorporating International Petroleum Technology*

2600 b/d Fluid Catalytic Cracking Unit Proves Successful on Initial 65-Day Run

First Commercial Small Capacity Fluid Catalyst Unit Goes On-Stream at Frontier Refining Co. Entirely New Design Reduces Overall Height, Eliminates Costly Cottrell Precipitators.

*By W. R. Newman**

COMPLETE success of a small capacity Fluid Catalyst cracking unit has been demonstrated in its initial run. The unit is a part of the new aviation gasoline refinery of the Frontier Refining Co. at Cheyenne, Wyo.

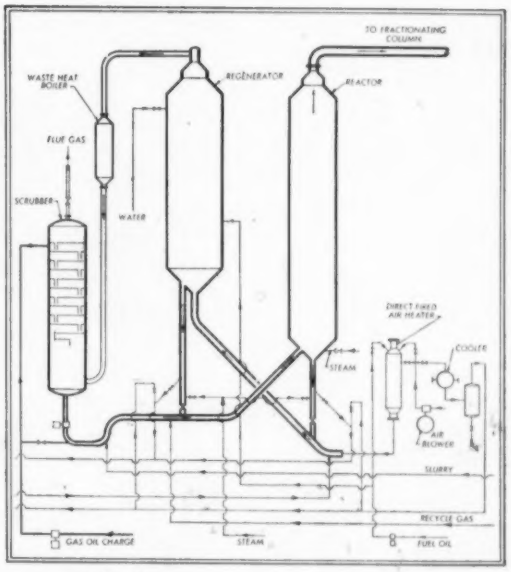
The design charging capacity of the unit is 2600 barrels per day of fresh gas oil. On its initial run, synthetic catalyst was used.

The results of this run go far toward answering a question which is of paramount concern to refiners in considering reconversion to peacetime operation, namely, "Is catalytic cracking a practical process for the small refiner?" The answer is encouraging.

After preliminary tests, the first run with synthetic catalyst was started May 3, 1944, and continued for 65 days.

On August 3, the Frontier management thought it wise to shut down the unit for inspection, during which special attention was given to the several new design features. All parts of the plant were found to be in excellent condition. All the innovations had proved themselves, furnishing a guide for the design of other units of small capacity.

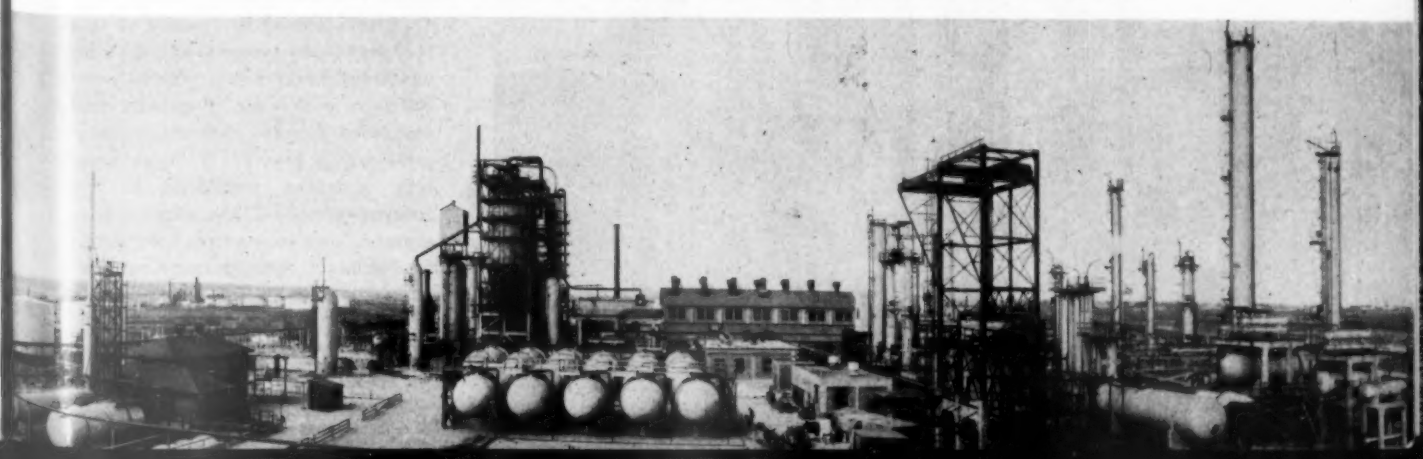
Designing a small fluid catalytic cracking unit presented special, difficult problems. It was not a matter simply of scaling down from the large size unit.



FRONT COVER: Flow diagram of the new small-capacity Fluid Catalyst unit at Frontier's aviation gasoline refinery, described in the accompanying article. Major design changes include (1) use of a scrubber (shown in left portion of diagram) to remove catalyst fines and (2) lowering of regenerator to reduce overall height of structure from 240 to 130 feet

Fig. 1

General view of the Frontier Refining Co., Aviation-Gasoline Plant, Cheyenne, Wyo.



*Vice President, Frontier Refining Co., Cheyenne, Wyo.

It was necessary to work out an entirely new design embodying hitherto unused principles and a number of new features, in order to reduce construction and operating costs.

The Frontier unit is of the single-stage type. Figure 1 is a simplified flow diagram.

Two of the fundamental innovations introduced in the design of this unit are:

1—Holding pressure on the regenerator which allows it to be placed approximately on a level with the reactor, thereby reducing the overall height of the structure.

2—A specially designed scrubber for recovery of catalyst from the regenerator gas, in place of the much more costly Cottrell precipitator which has been installed for this purpose in the larger fluid catalyst cracking units.

Regenerator, reactor and line diameters were fixed on the basis of velocities similar to those used in the larger plants, with some margin provided because of the uncertainty of actual charging stock and carbon production.

M. H. Robineau
President of the Frontier Refining Co. at Cheyenne

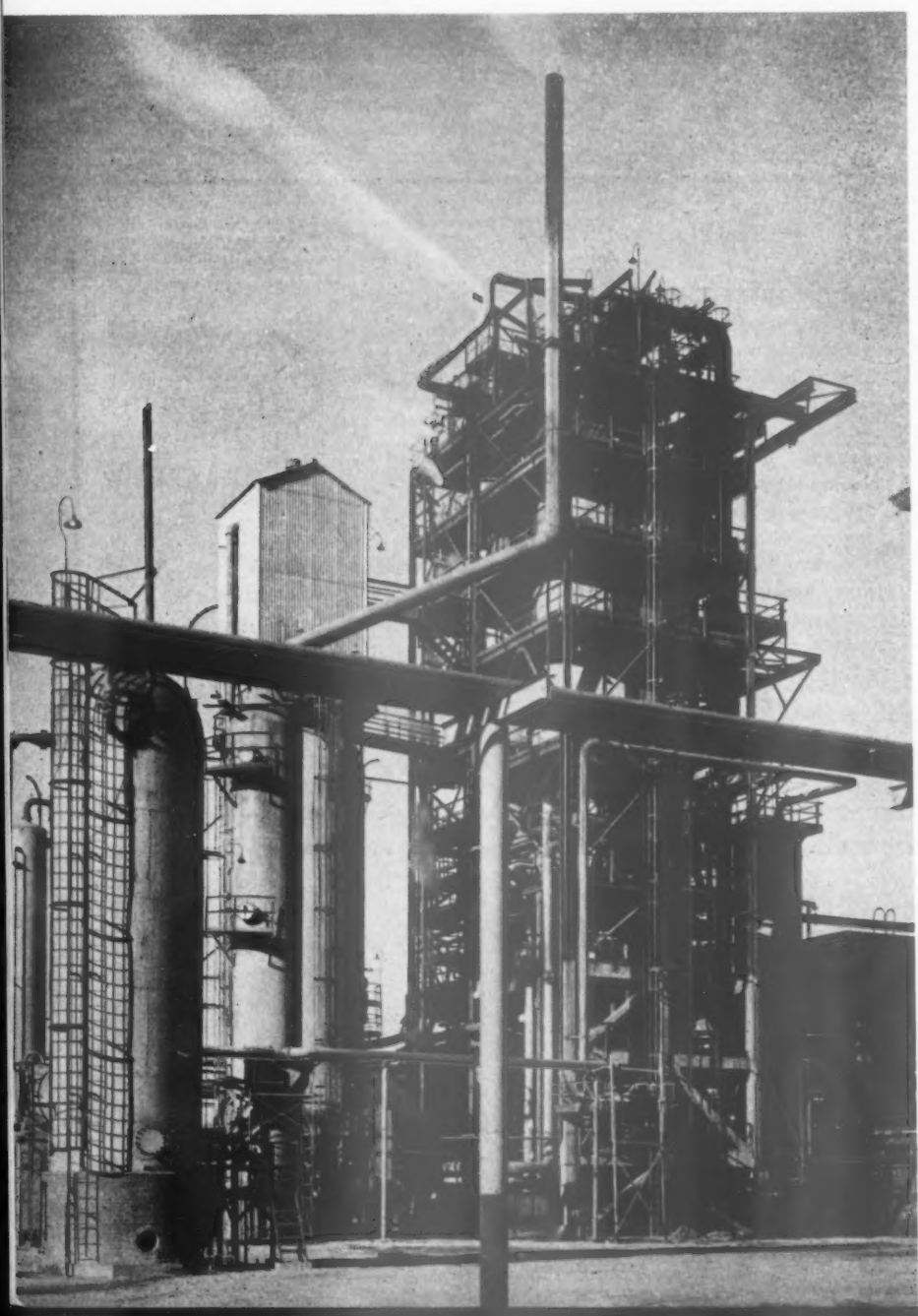
W. R. Newman
Vice-president in charge of refining, and author of the accompanying article

The major vessels are provided with skirt supports long enough to flex with the expansion of the vessel and avoid introduction of dangerous stresses or loadings at lug or stiff base supports.

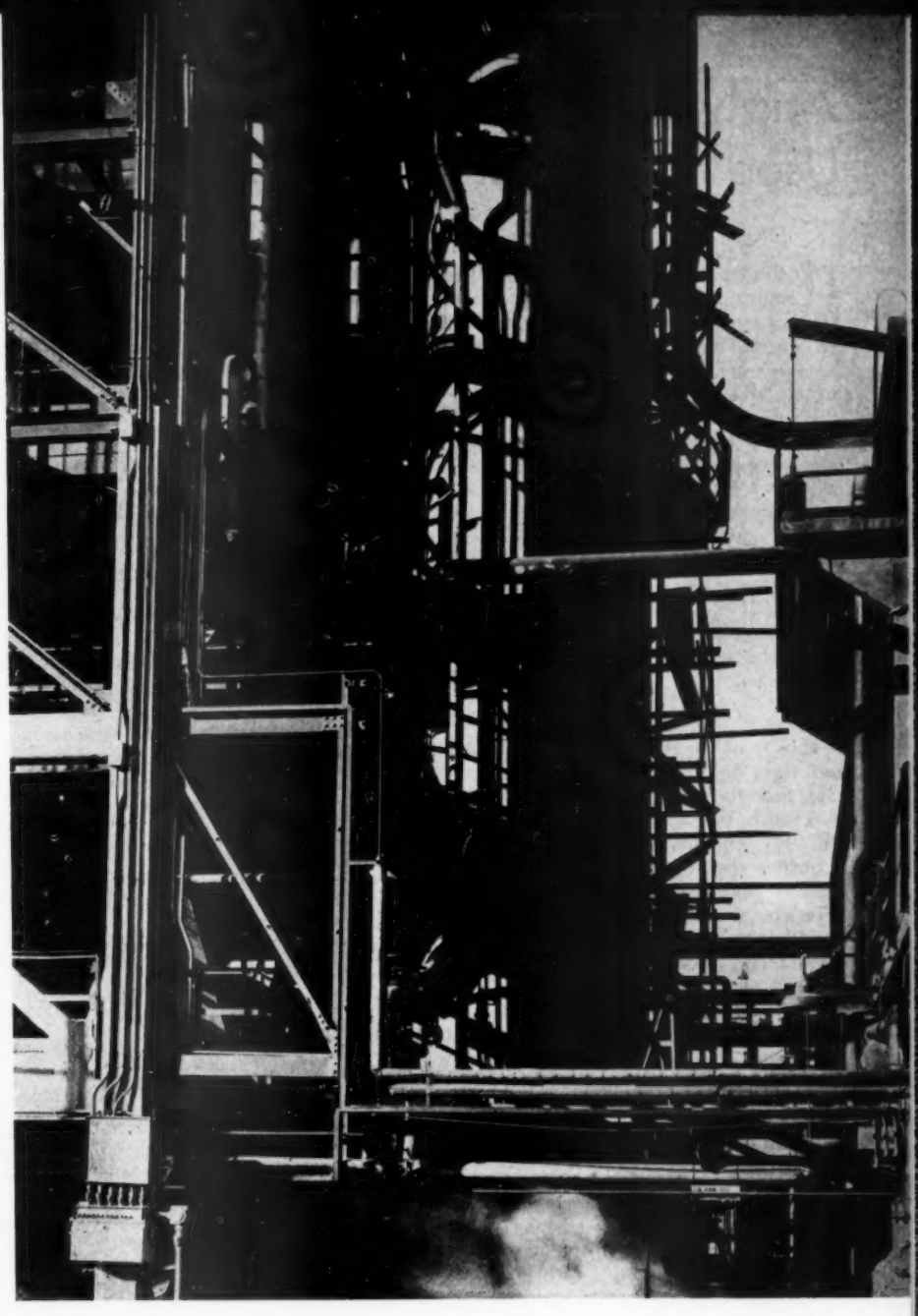
Distribution of catalyst and gas or vapor in both regenerator and reactor is accomplished by means of Meehanite grids.

The stripping section at the base of the reactor is proportioned to give approximately 2½ minutes residence time to allow cracking and removal of hydrocarbons by the stripping steam.

The reduced elevation of the regenerator results in relatively short standpipes and risers and minimizes the expansion problem in catalyst-carrying lines. Furthermore, since the small size of these lines makes internal insulation difficult



General view of Frontier's new small-capacity Fluid Catalyst unit. This unit is relatively small in size (130 feet high) compared to the conventional Fluid units, which tower 240 feet in the air. Frontier's unit embodies several new design features which promise to make catalytic cracking available to the smaller refineries. The plant is government owned, operated by Frontier under a management contract with DSC



Closeup view of scrubber on Frontier Refining Co.'s new 2600 b/d Fluid Catalyst unit. This scrubber removes the catalyst fines from the regenerator flue gases, eliminating the Cottrell precipitators used on conventional type Fluid units. It has proven highly successful in initial runs at the Frontier plant since it went on stream last Spring, according to company engineers

to apply, 4-6 chrome alloy lines, insulated on the outside, were used in direct contact with the catalyst. Conventional corrugated expansion joint equipment is used to handle the hot line expansion.

Constant pressure is maintained on the cracking unit receiver by the use of a controller operating on steam to the gas compressor and holding relatively constant pressure on column and reactor, particularly at constant vapor load.

The regenerator pressure is controlled by a differential pressure instrument which maintains a constant differential between reactor and regenerator and greatly assists in smooth operation of the catalyst slide valves.

The spent catalyst slide valve, which withdraws catalyst from the reactor, is operated by remote hand control through hydraulic mechanism from the board. The regenerated catalyst slide valve is operated by the catalyst inventory in the reactor.

In general, conventional instrumentation is used for measuring air flow, temperature, differential pressures, etc. A CO_2 meter is provided for a continuous analysis of the combustion products from the regenerator. An emergency by-pass controller is provided to hold constant pressure on the receiver and release gas to the blowdown system in case of a compressor shutdown or valve failure.

Multiple cyclones are provided in both reactor and regenerator to reduce the catalyst loading in the streams of hydrocarbon vapor and combustion gas leaving the reactor and the regenerator.

On leaving the cyclones, the regenerator gas, together with catalyst fines, passes through a waste heat boiler and then to the oil scrubber, which as previously mentioned, replaced the Cottrell precipitator used on other units for catalyst recovery.

Conventional pumps, air heater and other mechanical equipment are used. One exception is that the air and gas compressors are steam driven, whereas most of the other catalyst cracking units are provided with gas engine drivers on compressors.

Steam generators are installed at several points, including heat recovery from combustion gas from regenerator and circulation of column bottoms.

A vertical waste heat boiler of the fire tube type is installed in the combustion gas line from the regenerator to the scrubber. It is estimated to pick up approximately 6,000,000 Btu per hour, generating 40 psi steam.

The exchange system on the fractionating column bottoms transfers heat by means of G-fin exchangers from the slurry oil, picked up from the bottom of the column, to water from the steam-disengaging drum. The steam is generated at 150 psi and under normal conditions approximately 6,600,000 Btu are recovered.

Successful overall operation of the entire Frontier plant results from a combination of thermal and catalytic processes, designed and licensed by Universal Oil Products Co. They are carefully balanced in relation to each other to produce all the components of 100-octane gasoline.

These processes include thermal cracking and reforming, catalyst cracking, hydrogen fluoride alkylation and butane isomerization. The components of 100-octane gasoline include isopentane, alkylate and high octane aviation base stock.

The Frontier fluid flow catalyst cracking unit produces isopentane, isobutane, olefins, aviation base stock, and recycle gas oil.

The thermal cracking and reforming units produce additional olefins and butanes, which along with the olefins from the catalytic cracking unit, go to the hydrogen fluoride alkylation unit for manufacture into alkylate.

Analysis of Fireproofing Methods Used in Refinery Construction

By E. F. Brummerstedt

DESPITE rigid precautionary rules, control instruments, relief valves, fire-fighting equipment and facilities, refineries are inherently subject to fire hazards because of the combustibility of the liquids and gases being processed.

Hence, the engineering staffs of the various refining and construction companies have developed elaborate specifications for the protection of equipment and structures in the event of a conflagration. Most of the fireproofing requirements involve the use of an insulating cover (a non-inflammable material of very low heat conductivity) for all main members of equipment-carrying structures, as well as major pieces of equipment.

Strength of Steel at High Temperatures

Tables and curves in steel handbooks and texts on strength of materials indicate that the ultimate strength of steel rises with the temperature until about 550° F., and then decreases rapidly with a further rise in temperature. For long periods of time at high temperatures (800° or above) a gradual and continuous deformation under constant load, called creep, adds to the high temperature strength problem.

The modulus of elasticity, which determines the flexural rigidity of beams, and the elastic limit of steel, however, decrease inversely with the temperature starting with atmospheric conditions. Hence, no credit is given in design codes for the increased strength at intermediate temperatures. The variations in allowable stresses at higher temperatures among the different codes reflects the discrepancies found in experimental creep values and short-time rupture tests.

In addition to the loss of strength and rigidity, high temperatures cause expansion in steel which may result in high thermal stresses, especially in fixed members.

All these factors indicate the desirability of keeping temperatures in steel structures down to a minimum in case of fires, and as a result various methods have been used to insulate steel against a rise in temperature. Most of these involve the use of concrete because of the latter's low thermal conductivity, incombustibility, economy and simplicity of application.

Fireproofing Specification

The following specification is a common standard in refinery industry for the protection of steel structures:

"All steel columns supporting heavy equipment such as towers, tanks, exchangers, main piping, etc. shall be fireproofed from the base up to and including beams or cross members transmitting equipment loads to columns. All steel columns supporting tower platforms shall be fireproofed from the base up to the nearest platform or horizontal bracing plane above the elevation 25 ft. from the base. The main bracing (horizontal and knee) and all members connected to fireproofed columns shall likewise be fireproofed. Columns supporting only one level platform less than 15 ft. high shall not be fireproofed.

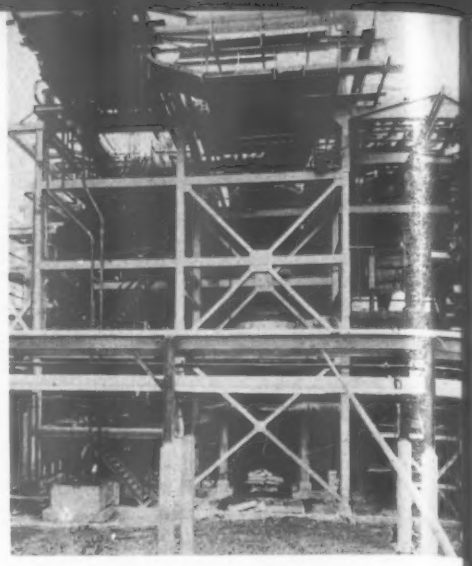
"All members to be fireproofed shall be wrapped with steel wire, 2 in. mesh, made of No. 14 gauge wire, before pouring fireproofing material.

"Fireproofing material shall be Portland Cement mortar, consisting of one (1) part cement to three (3) parts sand by volume, and poured solid around steel members, forming a square or rectangular cross section.

"Fireproofing shall have a minimum thickness of 2 in."

Guniting

The above specification applies primarily to the pneumatic applications of concrete commonly called "guniting". The consensus among refinery engineers and construction superintendents favors this method as being the simplest and most economical in the majority of cases. Its use is limited only by the practical consideration of availability of a gun and an experienced operator to handle it.



A typical fireproofing job applied to the structural steel work of a modern refinery

Its principal disadvantage is the amount of cleaning required, i.e., removal of excess concrete splattered on adjacent pieces of equipment or structural members which were not intended to be covered, and were not protected against this. The splatter loss, commonly-called "blow-back" in the field, is usually not in excess of 20% with an experienced operator. For this reason it is important that guniting be done immediately after erection of the steel structure and before installing of adjacent piping, conduits, small pipes, etc.

Any economic analysis of guniting must consider so many different factors that it is impossible to derive a constant unit cost to cover all cases.

The first item is the cost of a cement gun machine, which is about $1500 for a standard N-1 size. Obviously this must be written off on several jobs over a period of years to arrive at an equitable unit cost; its purchase is not warranted for a single small construction job. In ordinary periods or peacetime conditions it is possible to rent a machine for about $150 a month, which would be the best solution for a small job lasting only a month or two.

The second item is the cost of the operating crews' services. The operator generally is paid about $2 per hour and the cost of his helpers would approximately double this figure, depending on the locality. In addition, the attachment of form pins and shooting strips requires preliminary work rather difficult to estimate and also dependent on size of members. The expected output per day depends very largely on the size of standard members to be fireproofed, varying from 50 to 70 bags for large members, and 30 to 50 bags for small members.

E. F. Brummerstedt, a frequent contributor to NPN's Technical Section, is associated with the Petroleum Refinery Division of Foster Wheeler Corp., New York. Two months ago he presented a method for "Horizontal Tank Calibration", and previous to that a series of articles on "Economic Design of Pressure Vessels."

Improvements in Plant Design and Construction

Experience in the use of substitute materials and methods, the nature of new processes installed, and technological developments in other industries have combined to bring about important changes in wartime refinery design and construction.

The effect of these various factors on postwar refineries is being reviewed for NPN's Technical Section by several authorities in a series of articles which will discuss these desirable wartime features and how they can be incorporated in future construction technique.

Included among the subjects to be covered are: Design of the Modern Refinery Control System; Location of Heat Exchangers, Compressors and Pumps; Use of Linings in Pressure Vessels; Foundations for Towers in Modern Processing Units, and others. The accompanying article, the first of the series, reviews Fireproofing Methods.

With 1:3 mix and 2 in. coverage, the area in square feet per bag will vary with the size of members again, varying from 7 square feet for angles to 10 square feet for large members and flat or cylindrical surfaces such as tower skirt linings.

Most costs and estimates are based on a unit volume of 1 yard, rather than on area of coverage, but the above figures illustrate the futility of trying to find the cost per yard of fireproofing on any particular job. Fireproofing sub-contractors will quote from $60 to $100/cu. yd. depending on the nature of the job, of which approximately $15 is material cost, including mortar and wire mesh. This would not include cleaning up, splatter loss and stray material.

Hence the prime economic criterion of whether or not to gunite, assuming availability of equipment and labor, is the status of erection of auxiliary refinery equipment, pipelines, etc. If this work is far advanced, it will probably be cheaper and quicker to use the second method of concrete fireproofing, i.e., poured concrete. However, an experienced construction superintendent usually avoids this by proceeding with guniting immediately after erection of the main structural steel.

Poured Concrete

Manually poured concrete fireproofing requires the erection of extensive framework by a gang of skilled and highly-paid carpenters, using far more man hours per cu. yd. of deposited concrete than the gunite method explained above.

On very large members the cost per cu. yd. would be competitive with guniting because of the smaller ratio of square foot of framework required per cu. yd. of concrete deposited. In order to keep this ratio down, for smaller beams no special indentation is made for the web, but a solid rectangular block is poured whose width is governed by the beam's flanges. The shapes used for various structural members are illustrated in Fig. 1.

Jobs whose design incorporates an unusually large number of clips welded to main members for support of piping conduits and miscellaneous equipment, might in some cases be advantageously fireproofed by the method; however, it is advisable to prepare the framework prior to installation or adjacent small piping which may impede the framework and concrete deposition.

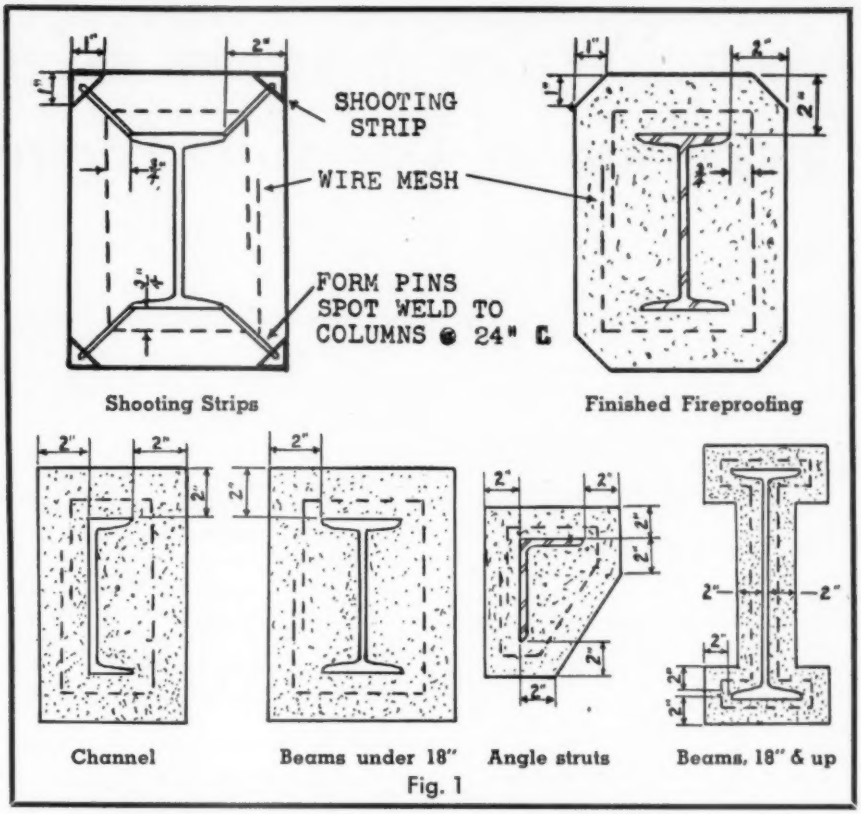


Fig. 1

In contrast to the higher labor cost per cu. yd., the material cost of poured concrete is less than that of gunite. The mixture is the common 1:2:4, including coarse aggregate, and hence less cement is required per unit volume of concrete. Secondly, there is no splatter loss; the actual volume of concrete used does not appreciably exceed the theoretical volume as calculated. The elimination of cleaning up, splatter loss, and chipping out fireproofing to attach small clips, makes this method more orderly and cleaner, but not necessarily more efficient than guniting.

Brickwork

A third method of fireproofing, applicable only to columns and large tower skirts, is embedment in brickwork. This method is ordinarily more cumbersome than concrete fireproofing and is used primarily for reasons of conformity with existing structures and brick buildings or to utilize available excesses of brick materials and brick-laying capacity.

Because it obviously cannot be used for beams and small members, its use would have the additional disadvantage of being inconsistent with the concrete fireproofing where required for the latter members. For accessible tower skirts this method is probably economically competitive, but for ordinary steel structures this is less likely.

Theoretically the method may have a slight advantage in that it is at least 4 in. thick and has a slightly lower thermal conductivity coefficient than concrete.

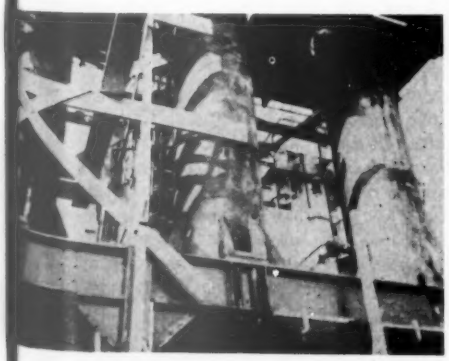
Prefabricated Methods

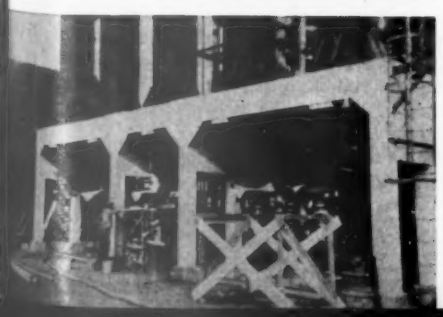
Another method of fireproofing is thru the use and application of prefabricated insulating blocks. These blocks are cut to fit the shape of the structural members and held in position by metal pins concealed in the insulation, which also protects the fasteners from fire. Its advantages are less weight, preformed and easier to install in places not easily accessible. It is also of pleasing appearance.

These blocks are made from a combination of vermiculite and asbestos with a small amount of binder. They weigh only about 1½ lbs. per sq. ft. one inch thick and can be handled as easily as wood. The material will not dissolve in water, and hence can withstand severe moisture conditions.

Despite these advantages, it has not been used frequently in refineries, primarily because of its somewhat higher cost, which based on unit area of coverage, is in the neighborhood of $1/sq. ft.

The above methods cover the majority of fireproofing applications. Others employing essentially the same principles have probably been tried by different refineries. None of these methods is so far out of line in costs as to preclude its use entirely, but, customer preference to the contrary, guniting is the preferred method of fireproofing among construction men.





Prefabricated insulating blocks applied to a large I-beam. Top, the beam before the blocks are attached. Bottom, the completed fireproofing job

Alcohol-Water Injection as a Detonation Depressor in Gasoline Engines

By A. T. Colwell, R. E. Cummings and D. E. Anderson

THE injection of water as an internal coolant is old in the art. The subject has received renewed interest because of its successful use on aircraft engines recently. Remarkable bursts of power have been gained for take-off and during flight, proving beyond question the value of an injected coolant, particularly in supercharged engines.

Recent tests have indicated that alcohol or alcohol-water injection is superior to water in many cases. Our tests indicate that 100% alcohol is more effective than alcohol-water, but the latter is less expensive and quite satisfactory.

The use of alcohol-water is not intended or expected to be a substitute for anti-knock quality in the fuel itself, but to supplement it and get maximum performance.

The effects produced by alcohol-water injection are not fully understood, but are probably a combination of the high latent heat of vaporization (water 970 Btu per pound, gasoline 150 Btu, ethyl alcohol 367, methyl alcohol 473, 50-50 ethyl alcohol and water, 675 Btu) and some function of specific heat. Rich mixtures have commonly been used for their cooling effect, but are uneconomical. Under severe conditions, cooling of pistons, valves, plugs, cylinder deposits and the cylinder head itself, suppresses detonation and pre-ignition, allowing higher power outputs.

Any Alcohol Is Suitable

So far as is known, any alcohol can be used. Extensive tests have been made with ethyl alcohol (C_2H_5OH), and some with methyl alcohol (CH_3OH) and isopropyl alcohol (C_3H_7OH). The alcohols supply Btu's to the charge (about 12,000 Btu's per pound), which are not supplied by water, and they also supply some oxygen. Further, alcohol is miscible with water and lowers the freezing point appreciably (50-50 solution alcohol and water, $-25°$F.).

Engine deposits are much softer and more easily removed when anti-detonant injection is used under variable load. On long full-throttle runs, some engines were remarkably clean.

It is the purpose of this paper to present the following data on anti-detonant injection for ground vehicles:

1. The theory,
2. Some history,
3. Recent test data, including wear, corrosion, engine cleanliness, and mineral deposits,
4. A simple automatic anti-detonant injection device for ground vehicles, including cost of operation, and
5. The possible field of use.

This paper deals with water-alcohol as an anti-detonant injection, and does not cover alcohol as a primary fuel.

It is realized that additional equipment is needed on a vehicle for anti-detonant injection, and that the supply must be attended to, just as in the case of gasoline. However, there are some operations where the advantages are being recognized at the present time, and there is considerable general interest in the subject.

The injection of water and water-alcohol mixtures as an internal coolant in aircraft engines has led to tests of the effect of such injection in engines of ground vehicles. Most of the tests were made with a 6-cylinder truck engine of 318 cu. in. displacement. Two compression ratios were used—6.45:1 and 7.25:1. Gasolines of various octane ratings were used. The injection mixture was made up of varying proportions of alcohol and water, and ranged in volume up to 25% of the total fuel mixture.

(The discussion in this paper is entirely of the advantages of alcohol-water injection. There are recognized disadvantages, which it is hoped may be brought out in later discussions—Editor.)

Theory

Every student of the internal combustion engine is aware of the importance of combustion control for good performance and satisfactory life. Several factors are involved in this study, among which are rate of burning, rate of pressure rise, and temperature of the charge during combustion. Recent developments indicate that much can be accomplished in the control of these variables by the introduction of certain internal coolants with the charge, at the proper time and in the correct quantity. Mr. Alex Taub has studied combustion for many years, and writes as follows:

"Internal cooling lowers the final temperature and eliminates detonation. Many experimenters who have photographed the movement of the flame front have written about the sensitivity of the flame front movement to varying temperature conditions inside the combustion chamber. Thus we have seen the flame front greatly speeded up as it passes over the exhaust valve and retarded as it passes over the intake valve. It is likewise speeded up as it passes over the hot center of the piston. The side walls of the combustion chamber actually appear to drag back the flame front as it absorbs the heat. For this reason the flame front proceeds as the sharp point of an egg instead of a sphere.

Combustion Proceeds in Stages

"The effect of any cooling agent upon detonation is classified by thinking of the process of combustion in stages. Taking, for example, an average passenger-car engine, stage one is the ignition; the gas pressure at this stage is compression pressure or around 150 lbs. per square inch. The second stage is when the flame has traveled about one-third the distance; the gas pressure in the unburned portion then is about 230 lbs. per square inch. The third stage is when the flame front has moved two-thirds of the way across the combustion chamber; the gas pressure in the unburned one-third being 350 lbs. per square inch.

"From this point on, what happens depends on the temperature of the last gas to burn. This gas, if in the hot area, would be ready to detonate with very little more flame movement. If this last gas is in a cool area, or has had the benefit of a cooling medium, or its temperature is held down by the work done and the work going on in vaporizing a cooling medium, then obviously the flame front completes the travel without self-ignition taking place in this last gas, and thus there is no detonation."

In determining the best cooling medium, when cooling alone is considered, it is natural to conclude that for this purpose the best coolant would be the one having the highest latent heat of vaporization—the required heat to change the liquid to a gaseous state—to be extracted from the air, or combustible mixture. The values for this property of the vari-

This article has been written from a paper entitled "Alcohol-Water Injection", presented at the annual War Engineering meeting of the Society of Automotive Engineers in Detroit, Jan. 8, 1945. The authors of the original paper, listed above, are all associated with Thompson Products, Inc., Cleveland, a firm known principally in the automotive and aircraft fields for its activities in the manufacture of engine valves. Mr. Colwell is vice-president, Mr. Cummings a valve engineer, and Mr. Anderson a consulting engineer.

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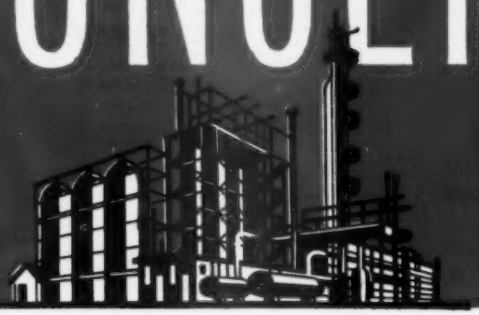

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ous liquids discussed in this paper are given below in British thermal units per pound:

Water	970
Methyl Alcohol	473
Ethyl Alcohol	367
Blend of Alcohol, 50%, and Water, 50%	675
Gasoline	135 to 150

It is not conclusive, however, that latent heat of vaporization is the only factor involved.

Alcohol, when used alone as a motor fuel, has an octane rating of 90 to 100, but tends to have a higher value when used as a blending agent. Most of our work has been with special blends of the various types of alcohols injected with the combustible mixture, using them only when required by the engine. Results indicate that burning characteristics of the charge are altered, reducing the rate of pressure rise, lowering peak values and fattening the indicator diagram.

The bmep thus developed is therefore greater because the expansion pressure points on the diagram are in a more advantageous position relative to the crank throw, whereas a higher peak pressure may be so placed that the force applied to the crank is less effective in producing torque. Water itself will reduce the degree of pressure rise and peak pressure (primary cause of detonation), but will contribute little toward fattening the diagram. However, if a slow-burning fuel, such as alcohol, is used as an antidetonant instead of or with water, the peak pressure will appear at a greater number of degrees past top center and the diagram will have a flatter top, fattening the diagram on the expansion side.

At higher speeds, volumetric efficiency is decreased and turbulence increased, lowering the octane requirement of the engine. However, at the speed of maximum torque and slightly above that speed, maximum detonation and shock take place. This range, therefore, will require the maximum amount of internal coolant injection. Beyond this range, the quantity can be reduced or entirely cut off.

Use of Injection in Truck Service

In truck service, however, where engines are operated at a continuous high power factor and at relatively high speeds, even though there is no audible detonation, it might be found desirable to continue to inject alcohol-water coolant beyond maximum detonating range to prevent pre-ignition.

When an engine is run on gasoline of the proper octane number, there should be very little benefit derived from the use of internal coolant injection. Best results are realized when there is a difference of approximately 10 to 15 octane numbers between the engine requirement and the fuel. The use of alcohol-water injection allows the use of lower-octane

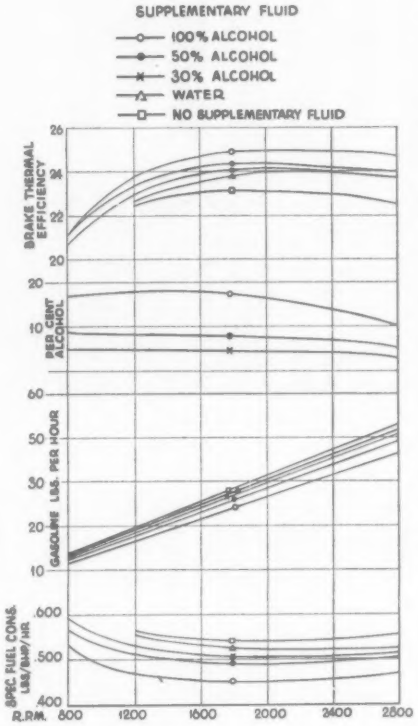


Fig. 1—Efficiency of various percentages of alcohol and water in internal coolant

fuel than that normally required by the engine, or allows the octane rating of the engine to be raised for greater economy and performance.

An important factor having to do with engine life and maintenance expense is engine roughness caused primarily by high pressure rise during the combustion process. This is the condition which knocks out bearings and causes fatigue of engine parts, and is therefore more injurious than moderate detonation. Aircraft fighter pilots have reported smoother engine performance with alcohol-water injection. Almost every driver of an automobile is conscious of how much smoother and more powerful his engine seems during foggy weather. What is actually taking place is moderate water injection, giving some shock control. Tests to be reported later in this paper show water injection to be beneficial in providing increased power and a smoother engine, but not equal to that which water plus alcohol or alcohol alone produces.

Quoting Mr. Alex Taub again:

"Injecting 20% alcohol-water mixture (50-50) may certainly be good for 1 to 1½ additional compression ratio. I am certain that 20% straight alcohol would do the trick.

"A special combustion chamber, incorporating all we know of shock control by design, should be combined with a higher compression ratio for this mixture. This would give returns in fuel consumption and performance with no additional punishment of the engine.

"Wear occurs mainly when engines are cool; that is why we have more wear during part throttle than full throttle.

"If alcohol-water is injected during the 'hot' period, there will be little likelihood of bringing about cylinder-bore wear—assuming the alcohol is more corrosive, which it is not. If alcohol-water is injected under hot conditions, it should be completely vaporized, and thus not be responsible for corrosion."

We must remember that one gallon of water results from the combustion of every gallon of gasoline and hence water vapor is already present in the cylinder.

Higher Compression Ratios

Higher compression ratios have ordinarily required addition of weight to the lower part of the engine. *The method of shock control by coolant injection may be a means of increasing compression ratio without adding weight to the engine.*

(In the section of the paper entitled "History" which is omitted, the few published data on this subject are reviewed, starting with work in England in 1913. Nothing in the art can be found, it is stated, where this development has been approached in the light of the recent advances in the knowledge of combustion phenomena.—Editor.)

Fig. 1.—A series of tests was conducted, using a six-cylinder passenger car engine of 217-cu. in. displacement, 6.5:1 compression ratio, to determine the relative efficiency of various percentages of both alcohol and water from 0 to 100% in an internal coolant best suited for power and economy. The fuel used was 64 octane. The curves plotted from these data are reproduced in Fig. 1 and show that when all factors are taken into consideration, the 50% alcohol and 50% water is the best average combination, particularly at the present price of alcohol.

It will be seen that when 50% alcohol and 50% water is used, the percentage of alcohol in the total fuel mixture (excluding the water) varies from 5½% at 2,800 to 9% at 800 rpm and the maximum brake thermal efficiency is 24.4%; the bte curve falling midway in the family of curves.

Using water, the bte curve is lower than the other curves, but this is not necessarily true of all engines, due to design differences. The water bte curve is slightly better than when no internal coolant was used, due to slightly higher power produced when water was injected.

Figure 2.—The test results shown in Fig. 1 having indicated that a 50-50 mixture of alcohol-water is economically best, additional tests were conducted with a 318-cu. in. heavy-duty truck engine to ascertain the relative merits of three cooling mediums, namely: water alone, alcohol 50% plus water 50%, and alcohol alone. 69.8-octane gasoline was used with a compression ratio of 7.25:1.

The family of torque curves shown in Fig. 2 indicates that water as a knock

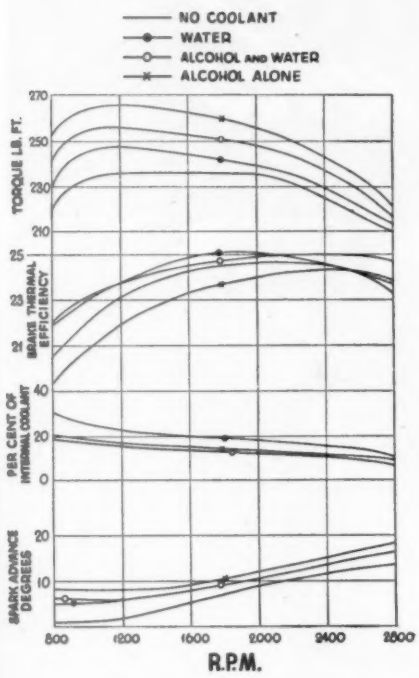


Fig. 2—Comparison of water, alcohol 50% plus water 50%, and alcohol alone as internal coolants

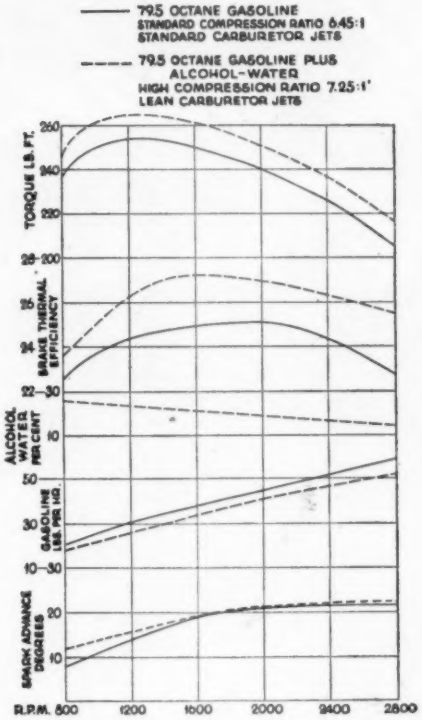


Fig. 3—Alcohol-water injection as a means for increasing power and efficiency

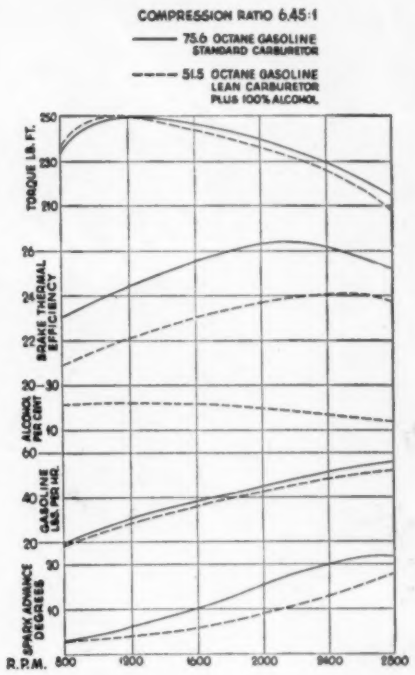


Fig. 4—Alcohol-water injection with low-octane fuel

suppressor is inferior to alcohol or alcohol-water mixture for this engine.

While the brake thermal efficiency curve for water is practically the same as that for alcohol-water, it will be seen that the power developed at 1,200 rpm with water is 9.0 foot-pounds lower, or 3½%. The spark advance for water is the same as for alcohol-water, indicating good anti-knock properties for both mediums except that for the same degree of detonation, roughly 50% more water than alcohol-water was required. The power produced being greater for the alcohol-water mixture substantiates the statement made earlier in the paper that the heating value of alcohol provides a fatter indicator diagram. This is further demonstrated when the 100%-alcohol curves are compared with those for plain water injection; in this case, the gain in torque for alcohol over water is 19 foot-pounds or 7.7%.

This figure presents another interesting comparison, showing how much the power of this engine can be increased when 100% alcohol is injected as an internal coolant. The torque gain is 30.5 foot-pounds or 13%. It will be noted, however, that the brake thermal efficiency when using alcohol is one percentage point lower than when no alcohol is used.

We must remember that the fuel used is considerably below the engine requirement in octane value.

Figure 3—Fig. 3 shows what can be accomplished by alcohol-water injection in increasing engine power and efficiency.

A truck engine of 318-cu. in. displacement was used and tests were conducted with two compression ratios, 6.45:1 and 7.25:1. ASTM 79.5-octane gasoline was used. This gasoline was selected because the consensus of postwar prognostication points toward octane numbers of approximately this value.

The full-line curves designate the best performance of the low compression ratio. The dotted lines cover the high-compression head performance using alcohol-water injection and lean carburetor setting.

Alcohol-water injection increased the maximum torque from 254 to 265 foot-pounds. The brake thermal efficiency was improved about two percentage points, from 25.15 to 27.25%.

The spark advance required with alcohol-water injection was higher at the low speed, indicating a lower rate of pressure rise. The amount of anti-detonant required was 25.5% at 800 rpm, decreasing to 16% at 2,800 rpm.

This comparison indicates that alcohol-water injection will be of interest with higher-octane fuel, particularly with higher compression ratios.

Figure 4.—Fig. 4 shows what injection of alcohol alone will do when an ex-

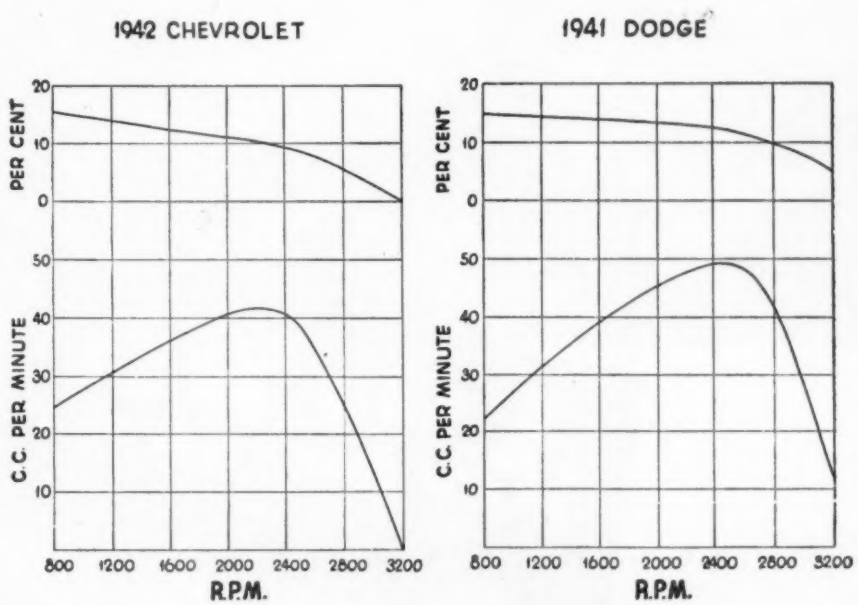
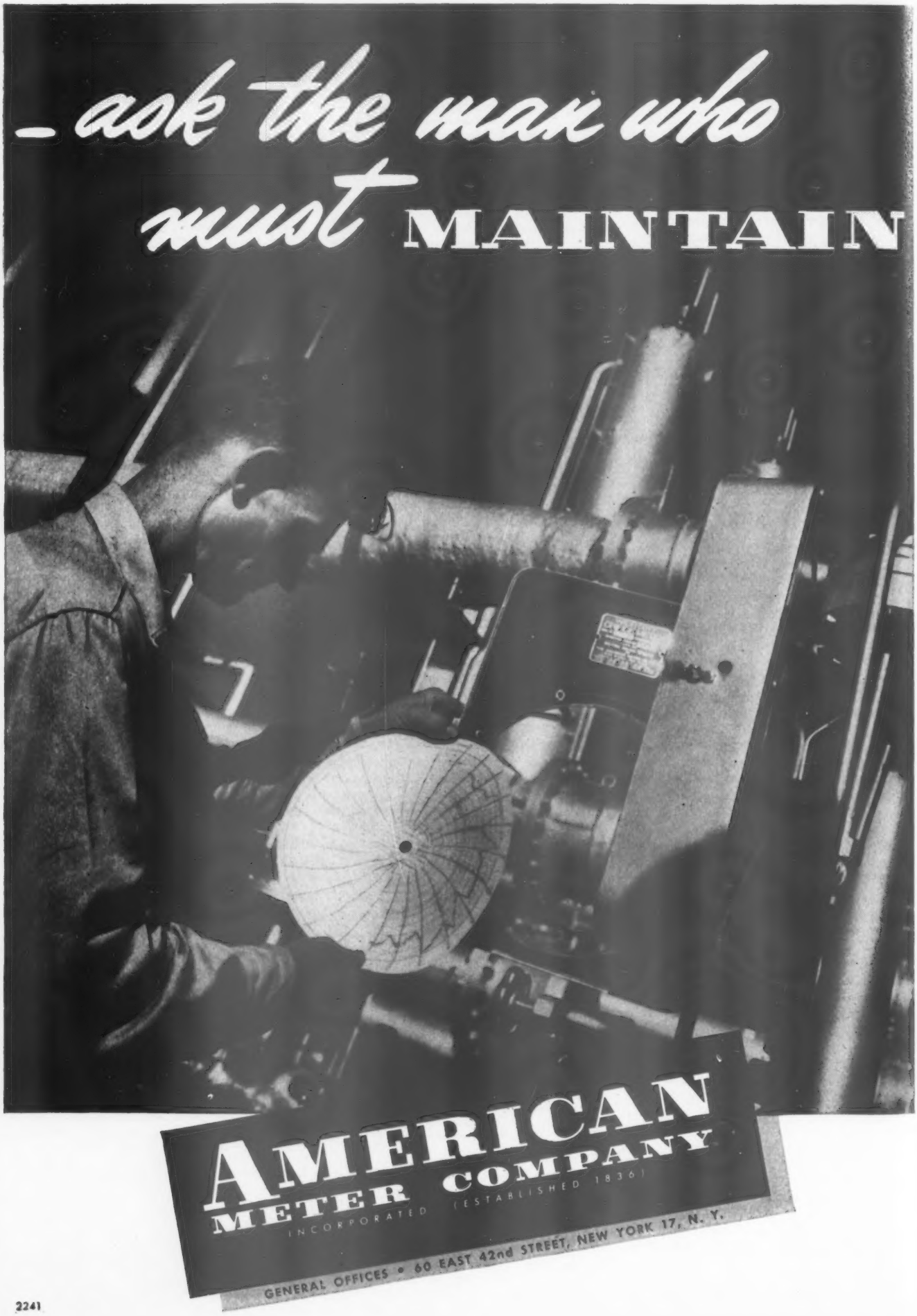


Fig. 5—Alcohol-water requirements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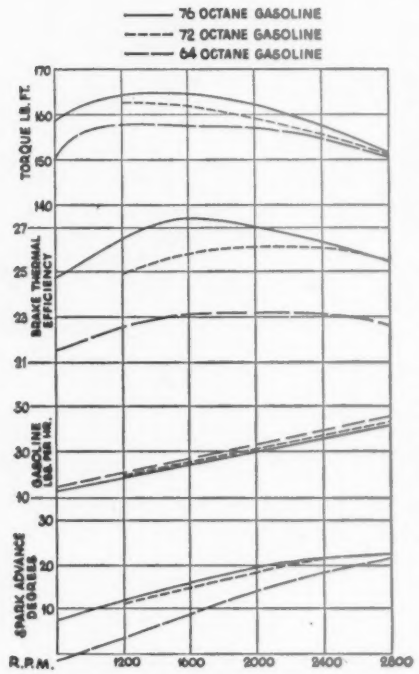

Fig. 6—Performance with three grades of gasoline using no internal coolant (6.5 comp. ratio passenger car engine)

tremely low-octane fuel is used in this truck engine with 6.45:1 compression ratio.

In these curves, the dotted lines designate the performance and other characteristics when using 51.5-octane gasoline, lean carburetor and 100% alcohol injection. Full lines show the results obtained with 75.6-octane gasoline.

The torque curves are comparable throughout the speed range and at 1,200 rpm, 250 foot-pounds are obtained in both cases.

The per cent of alcohol required for best borderline knock performance ranged from 22% by weight at low speed to 14% at 2,800 rpm.

The spark curve with alcohol injection indicates the effect of using a low-grade fuel for which the combustion chamber was not designed.

The brake-thermal-efficiency curve shows the low-octane fuel plus alcohol inferior to the higher-octane fuel. This condition could be somewhat improved with alteration in combustion-chamber design. It therefore becomes uneconomical to bridge a gap of 24 octane numbers by the use of alcohol injection.

Figure 5.—Curves in Fig. 5 show alcohol-water requirements for two popular passenger-car engines, using 64-octane gasoline.

They also demonstrate the desired flow rate of an automatic injection device or dual-fluid carburetor. It will be noted that the requirement for an anti-detonant peaks rather sharply in the mid-speed range, reducing rapidly above this point.

Figure 6.—Full-power curves (Fig. 6) of tests on one of these engines, a six-cylinder, L-head type, 6.5 compression ratio, with different octane fuels, show practically the same power output at top speeds for all grades, 64, 72 and 76 octane numbers.

It will be noted that through the maximum-knock and maximum-torque speed range (1,000 to 2,000 rpm) the brake thermal efficiency is highest for the 76-octane gasoline and quite low in comparison for the 64-octane number. We can conclude from these curves, considering bte, torque and spark advance as important in selecting the best fuel, that at least 76-octane gasoline is required by this passenger-car engine if an internal coolant is not used.

Figure 7.—It has been common practice to enrich the carburetor to reduce detonation and provide for a degree of internal cooling. From a thermal efficiency standpoint, this is not good practice, as will be shown by an analysis of Fig. 7. A compression ratio of 7.25:1 and 79.5-octane gasoline were used. The dotted lines designate the standard mixture and the full lines show the rich carburetor setting. The degree of enrichment, as shown in Fig. 7, was 17% at 800, 26.5% at 1,600 and 20.7% at 2,800 rpm.

The torque curves show only a difference of 2 to 3 foot-pounds gain for the rich mixture with a maximum brake thermal efficiency of 21.6% for the rich mixture as against 26.8% for the standard.

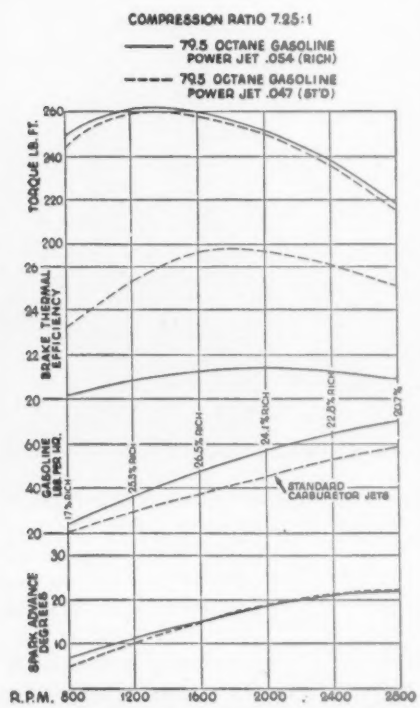

Fig. 7—Comparison of rich and standard carburetor settings

Figure 8.—Fig. 8 is a comparison of results on a 7.25:1-compression-ratio engine, between 79.5-octane fuel (rich mixture) and 69.8-octane fuel (lean mixture) with alcohol-water varied between 20% and 30% through the speed range. Power and spark advance are about the same.

The spread between brake-thermal-

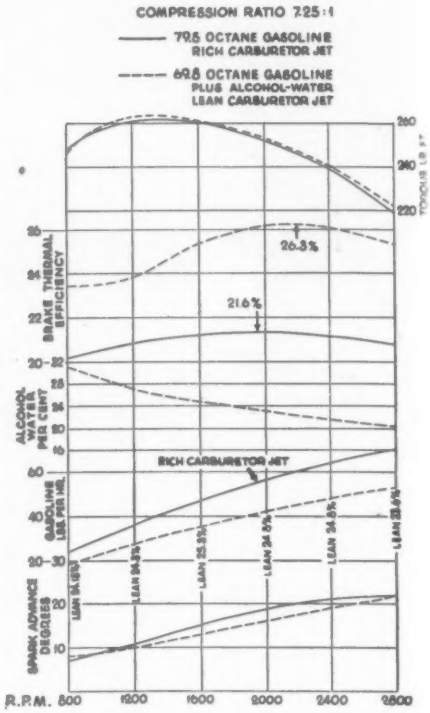

Fig. 8—Comparison of 79.5-octane gasoline (rich mixture) and 69.8-octane gasoline (lean mixture) using alcohol-water injection

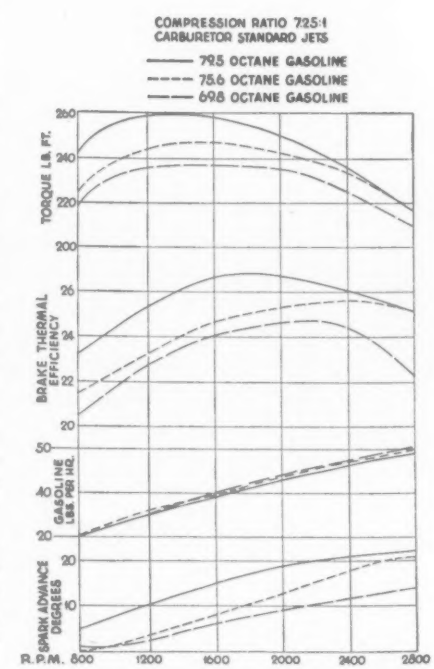

Fig. 9—Performance with three grades of gasoline using no internal coolant

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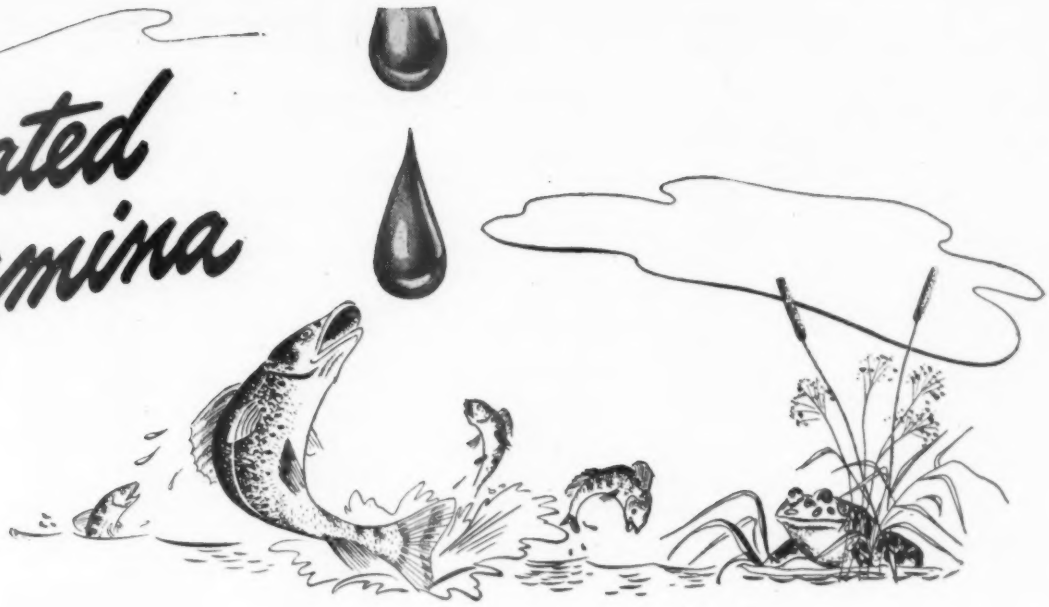

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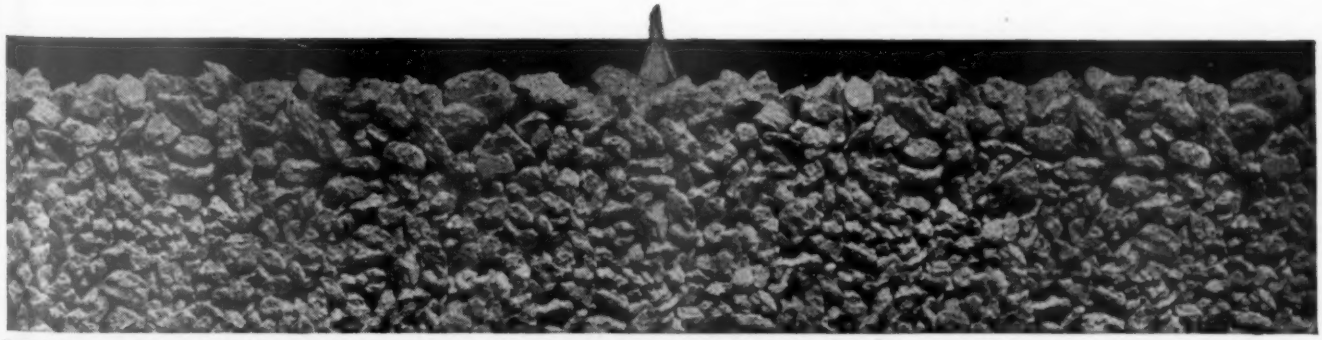

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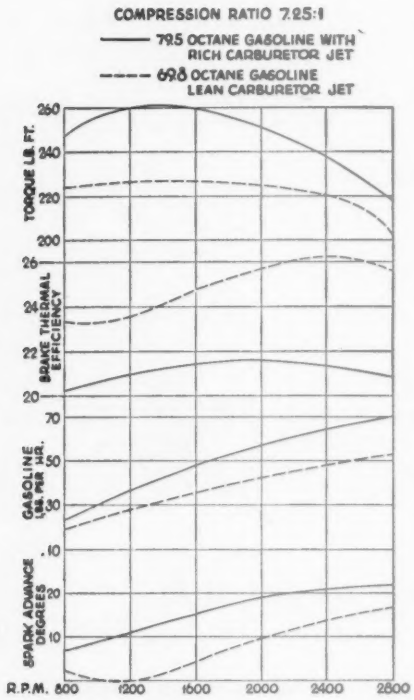
COMPRESSION RATIO 7.25:1
79.5 OCTANE GASOLINE WITH RICH CARBURETOR JET
69.8 OCTANE GASOLINE LEAN CARBURETOR JET
TORQUE LB. FT.
BRAKE THERMAL EFFICIENCY
GASOLINE LBS. PER HR.
SPARK ADVANCE DEGREES
R.P.M. 800 1200 1600 2000 2400 2800

Fig. 10—Comparison of 69.8-octane gasoline (lean carburetor, no internal coolant) and 79.5-octane gasoline (rich carburetor mixture)

efficiency curves (26.3% vs. 21.6%) demonstrates that internal cooling with over-rich mixtures will be uneconomical. It is, however, the simplest method, since no additional accessories are needed for the fuel system.

Figure 9.—Fig. 9 is a family of curves for 7.25:1 compression ratio, presented to show the performance of three grades of gasoline used in this investigation: 69.8, 75.6 and 79.5. It will be seen that in every respect, power, brake thermal efficiency and spark characteristics, the higher-octane gasoline is best.

This test was run using the standard carburetor setting. A fuel higher than 79.5-octane gasoline was not available and probably still further improvement would have ensued, had a test been made with such fuel.

Figure 10.—Fig. 10 is presented to show that 69.8-octane gasoline alone, with a lean carburetor setting is unsuited for this 7.25:1-compression-ratio engine. The spark advance is quite short, which indicates such a rapid pressure rise that the power output is greatly reduced and detonation is induced. At the point of medium torque and detonation (1,200 rpm), the spark setting for borderline detonation is at 0° advance while for 79.5-octane gasoline, 11° is required.

The bte with the 69.8-octane gasoline for best economy is considerably higher than for 79.5 for best power. The difference between these two curves is the gain that is had when alcohol-water is added to the 69.8-octane gasoline. This will be seen by reference to Fig. 11.

Figure 11.—In Fig. 11 alcohol-water injection has been added to the 69.8-octane fuel of Fig. 10. The dotted curves designate 69.8-octane gasoline plus alcohol-water and the full lines, 79.5-octane gasoline. It will be seen from an examination of these curves that there is not a great deal of difference. Since performance is about equal, we conclude that the alcohol-water is responsible for approximately 10 octane numbers at 1,200 rpm. Alcohol-water at this point is about 28% of the total fuel.

Figure 12.—Fig. 12 shows curves covering the use of 69.8-octane gasoline plus alcohol-water injection and 79.5-octane gasoline, using 7.25:1 compression ratio, and the standard carburetor setting. As far as power is concerned, this test shows that the addition of an internal coolant to the lower-octane gasoline will improve the rating of the fuel by at least 10 octane numbers when the percentage of the alcohol-water blend used is from 21½% at 1,200 rpm to 10% at 2,800 rpm. The bte curves show lower values for 69.8-octane gasoline. This is due to the fact that the carburetor is too rich when alcohol-water is added.

(The concluding portions of the paper are omitted. These include:

(Figure 13, which is a tabulation of performance tests run on a Model A120-A White engine, the results being representative of the other tests.

(A section on "Procedure and Instrumentation," which describes the dynamometer and instrumentation setup used during the investigation.

(A section entitled "Engine Wear, Corrosion and Cleanliness," in which the conclusion is made that alcohol-water or water injection is not a cause of internal engine corrosion when the injection is under prescribed conditions.

(A section which describes an automatic injection device for installation on ground vehicles.

(A section on "Cost Analysis" which shows permissible alcohol cost when using cheaper gasoline with injection.

(A summary in which it is stated that a 50-50 alcohol-water injection appears to be the most economical fluid for best results. The alcohol content used may be a blend of various alcohols for denaturing purposes and to gain the best properties of each type.

(A principal field of use for injection is seen for light aircraft engines, which operate at full load only a small portion of the time and will likely be designed to operate on fuel for ground vehicles after the war—Editor.)

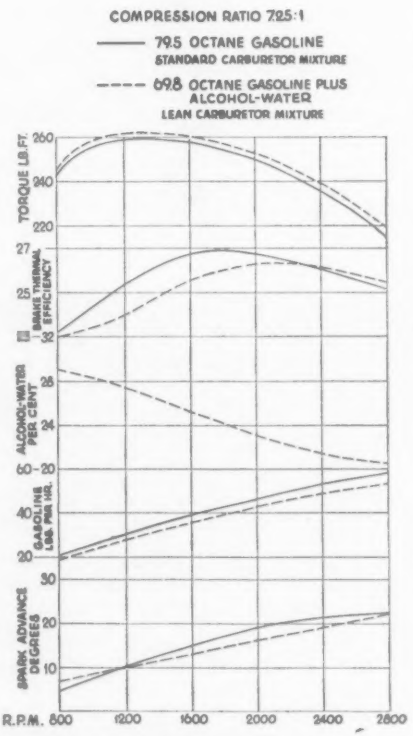
COMPRESSION RATIO 7.25:1
79.5 OCTANE GASOLINE STANDARD CARBURETOR MIXTURE
69.8 OCTANE GASOLINE PLUS ALCOHOL-WATER LEAN CARBURETOR MIXTURE
TORQUE LB. FT.
BRAKE THERMAL EFFICIENCY
ALCOHOL-WATER PER CENT
GASOLINE LBS. PER HR.
SPARK ADVANCE DEGREES
R.P.M. 800 1200 1600 2000 2400 2800

Fig. 11—Comparison of 69.8-octane gasoline plus alcohol-water injection with 79.5-octane gasoline and standard carburetor mixture

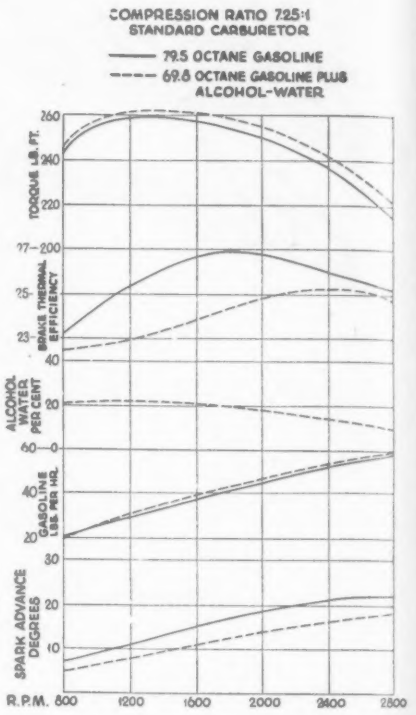

Fig. 12—Value of alcohol-water injection in octane numbers

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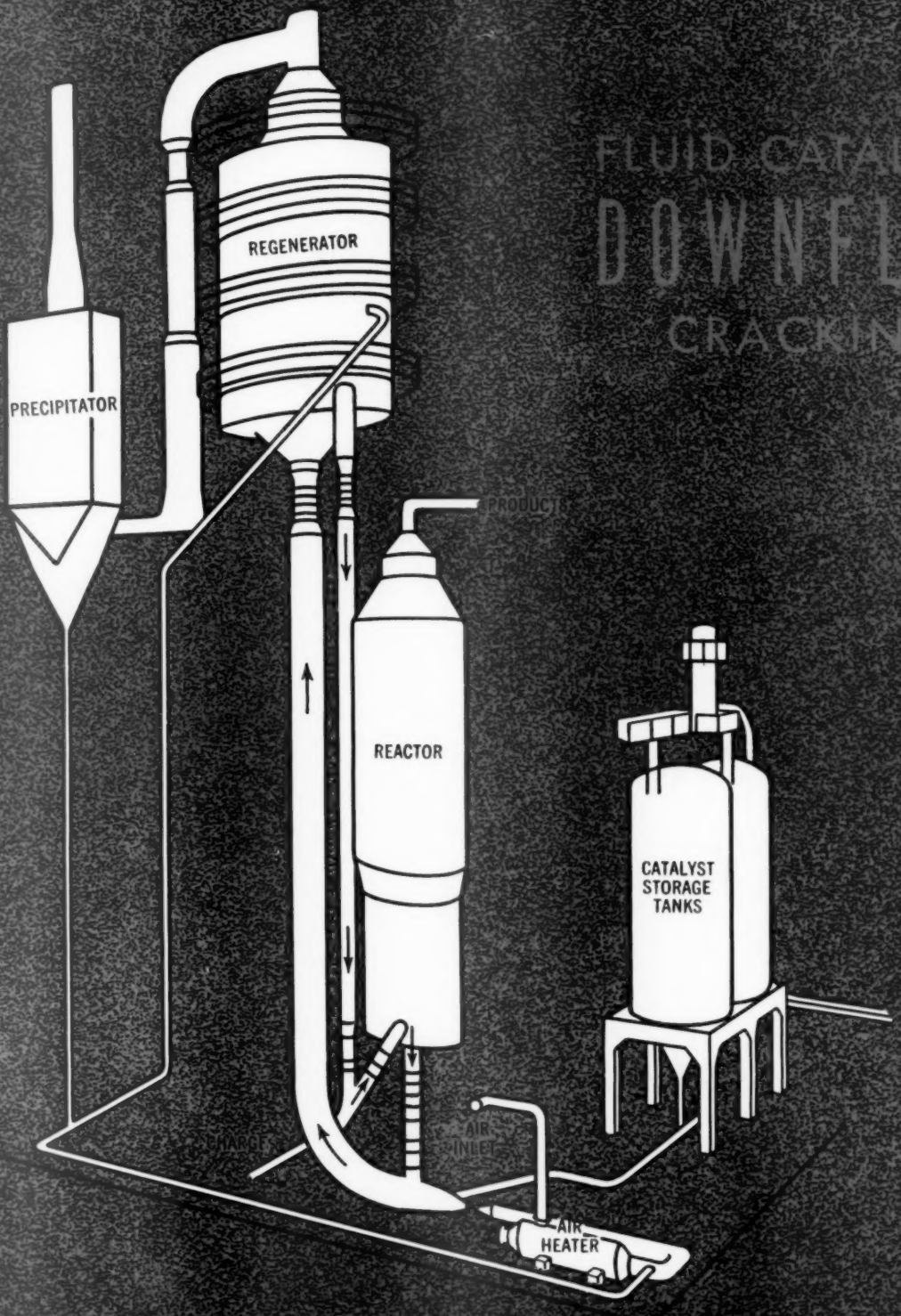

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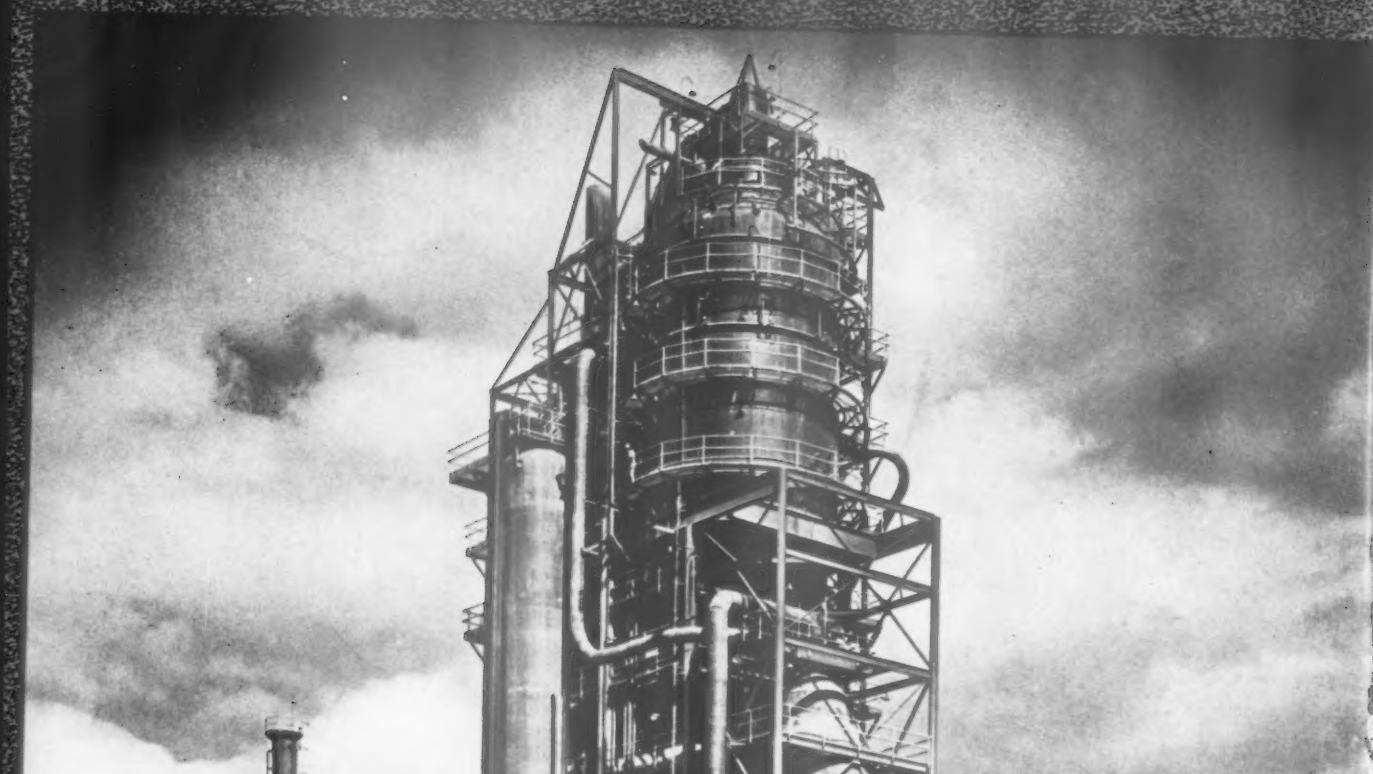

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Fischer-Tropsch Synthesis and The Petroleum Industry

By V. I. Komarewsky and C. H. Riesz
(Department of Chemical Engineering, Illinois Institute of Technology and Institute of Gas Technology, Chicago)

Increasingly wide-spread attention and interest are being centered on the Fischer-Tropsch process as a commercially economical means of synthesizing gasoline and other petroleum products. The reasons for this interest are discussed in this article, with special reference being given to the utilization of natural gas to produce gasoline. The development of the Fischer-Tropsch process and possible reaction mechanisms are described to aid in the prediction of future trends for applications of this method of synthesis by the petroleum industry.

The authors are two prominent chemists, who have done considerable research work on the subjects of gas technology and hydrocarbon synthesis. They have prepared this article exclusively for the Technical Section of National Petroleum News, although it has been based on a paper they presented before the Gas and Fuels Division at the annual meeting of the American Chemical Society, New York, Sept. 11-15, 1944[1]

THE QUESTION of American oil reserves and their depletion has occasioned considerable controversy because factors, such as new discoveries of oil and improved methods of oil production, cannot be thoroughly evaluated. Regardless of the exact answer, the fact remains that the war has drawn heavily upon our petroleum resources. In order to insure national self-sufficiency and the future of the petroleum industry, alternative sources of "oil" must be investigated.

Of the many methods of producing oil substitutes, only four need be considered by the petroleum industry:

1. hydrogenation of coal
2. distillation of oil shale
3. treatment of tar sands
4. Fischer-Tropsch synthesis

Of the above, the Fischer-Tropsch synthesis is outstanding due to flexibility and mild operating conditions. Support of this conclusion is evident from the extensive work on this process being carried out in the research laboratories of the major oil companies. It seems well to examine the reasons for this wide-spread interest.

The Fischer-Tropsch synthesis of hydrocarbons is based upon the catalytic reduction of carbon monoxide by hydrogen according to the following equation:

$$x\,(CO+2H_2) \longrightarrow (CH_2)_x + x\,H_2O \quad \ldots\ldots (1)$$

In the above, x depends upon the conditions of the reaction and the entire series of hydrocarbons from methane to paraffin wax is usually received. Thus, 1000 cu. ft. of synthesis gas (33.3% carbon monoxide; 66.7% hydrogen) theoretically will give approximately 2 gals. (12.3 lbs.) of hydrocarbon material. Actually, however, incomplete reaction and gas formation reduce the yield of product. In practice, the yield of hydrocarbons, other than methane, ethane and ethylene, is 1.4 to 1.5 gals. (9.5 lbs.) per 1000 cu. ft. of synthesis gas.

The so-called synthesis gas is a mixture of one part carbon monoxide and two parts hydrogen by volume. The flexible nature of the Fischer-Tropsch process is evidenced by the fact that any carbonaceous material can be transformed to carbon monoxide-hydrogen mixtures by suitable means. This is important since it means that our tremendous coal reserves guarantee an internal source of hydrocarbon fuel for many centuries. Of great interest for the present is the fact that natural gas is readily converted to synthesis gas and this, in turn, can be transformed into gasoline and other petroleum-like products by means of the Fischer-Tropsch process. The reactions by which natural gas can produce the required synthesis gas are the following:

$$3CH_4+2H_2O+CO_2 \longrightarrow 4CO+8H_2 \quad \ldots (2)$$

$$2CH_4+O_2 \longrightarrow 2CO+4H_2 \quad \ldots (3)$$

The question of natural gas reserves thus becomes an important factor. The proved reserves of natural gas in this country has been estimated at 100 trillion cu. ft.[2] If an 85-90% conversion to synthesis gas is obtained, the total natural gas reserves could be converted into about 9 billion bbls. of high-grade synthetic oil by present methods. Since the proved crude oil reserve in the United States is about 20 billion bbls.[3], it is evident that the conversion of natural gas to synthetic oil is an important consideration.

With natural gas at 5 cents per 1000 cu. ft., Russell estimates that the cost of gasoline on the basis of German data is 8.8 cents per gal.[4] Other estimates are at variance with this figure; thus, Williams calculated a cost of 17.4 cents per gal.[5] However, Russell believes that improved design will lower the cost of gasoline to 4.8 cents per gal.[4] These figures should be compared with the cost of 5.3 cents per gal. for gasoline obtained by thermal cracking of crude oil priced at $1.20 per bbl. (Table 1). A second factor for economic consideration is the plant investment. It is estimated that from 3 to 9 times the plant investment for thermal cracking of crude oil will be required (Table 1).

One important variable cannot be evaluated in these calculations, which are based mainly on 1938 German data. This factor is the progress of the petroleum industry during the past few years, especially in the field of catalytic reactions. Application of developments in related processes, such as catalytic cracking, hydroforming or isomerization, may lead to reduced plant and operating costs for the Fischer-Tropsch synthesis. In addition, the discovery of a practical method of producing iso-hydrocarbons directly would change the whole economic situation.* High-octane gasoline could then be received instead of the present 40- to 55-octane, untreated product. All calculations of cost, therefore, are subject to this revision. However, it would appear that natural gas could be converted to gasoline economically in certain areas at the present time.

If the conversion of natural gas to gasoline is possible economically, is this the best means of utilizing natural gas? This valuable natural resource now plays an important part in the national fuel economy. Another use is in the production of carbon black where 1 cent per 1000 cu. ft. has been common.[7] Natural gas as a raw material for chemicals produc-

Synthetic Gasoline For 5c a Gallon

SYNTHETIC gasoline of 75 octane rating (motor method) can now be produced from natural gas for a cost of about 5c per gallon, according to a recent announcement by the M. W. Kellogg Co. (*See NPN Jan.* 10, 1945, *pg.* 44).

The method used is a modification of the Fischer-Tropsch process, and is the result of new engineering developments worked out by the company in its laboratories in Jersey City, N. J.

Kellogg's engineers claim that yields of 80% of the 75-octane fuel have been obtained and that its rating can be increased to 80-octane (89-octane—research method) by the addition of 1 cc of tetraethyl-lead.

The cost of 5c a gal. for the synthetic gasoline is based upon using natural gas costing 5c per MCF for the basic raw material. Kellogg states that they are now prepared to build hydrocarbon synthesis plants employing their method and utilizing natural gas.

*Myddleton[6] has presented calculations which indicate that the synthesis of the lower iso-hydrocarbons is thermodynamically possible. Also, refer to *Recent Developments* in the present paper.

TABLE 1

	Investment Dollars per bbl. gasoline per day	Total cost of Gasoline
Improved design[4]	2200	4.8
European design[4]	4750	8.8
European design[5]	6180	17.4
Modern oil refinery,[4]		
crude at $1.20 per bbl.*	700	5.3
crude at $2.00 per bbl.*	700	8.5

* Using thermal cracking basis

tion has consumed only a small fraction of the total production. The proper answer to the above question is that our gas reserves are of a sufficient magnitude so that each utilization, including the Fischer-Tropsch synthesis, will have its own place.

Historical Development

The pioneering work in the production of hydrocarbons from water gas was that of Sabatier,[8] who found that finely divided nickel would catalyze the reduction of carbon monoxide to methane.

$$CO+3H_2 \longrightarrow CH_4+H_2O \quad \ldots\ldots(4)$$

This reaction could conceivably produce synthetic natural gas from coal. However, two major technical difficulties are encountered, namely, poisoning by sulfur and poisoning by carbon deposition. The latter is caused by a blanketing of the active catalyst centers according to the following reaction:

$$2CO \longrightarrow C+CO_2 \quad \ldots\ldots(5)$$

The conditions favoring the production of methane rather than the Fischer-Tropsch synthesis of higher molecular weight hydrocarbons are: (a) catalyst, (b) relatively high temperatures, and (c) high proportion of hydrogen in the reacting gases. Nickel and iron catalysts are active at atmospheric pressure. The temperature required is about 570° F. for nickel catalysts. The ratio of hydrogen to carbon monoxide theoretically should be three (Equation 4).

It is of passing interest that carbon dioxide may be hydrogenated to methane at 570° F. over a pure iron catalyst.[9] Ruthenium powder or ruthenium-thoria-asbestos also may be used for the production of methane from CO_2 at 212° F.[10] However, after the initial step which is conversion to carbon monoxide and water vapor, the reduction proceeds according to Equation 4.

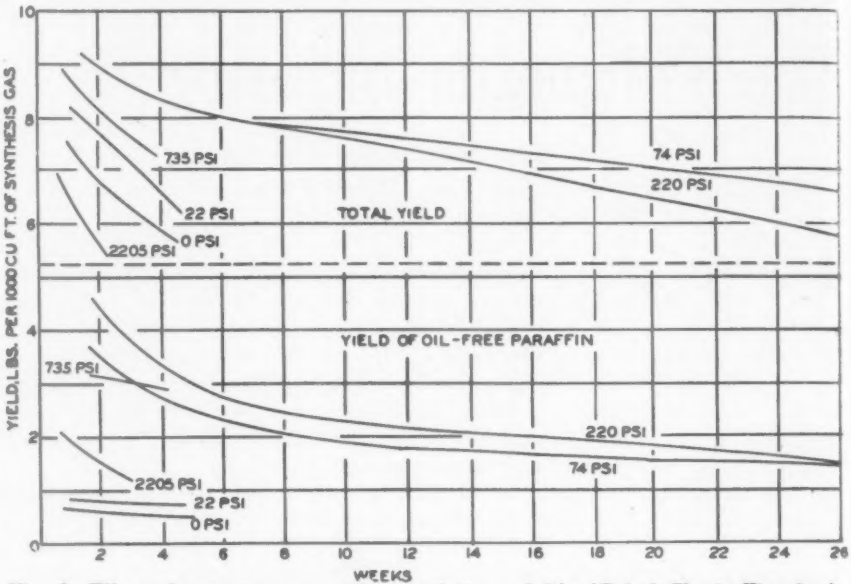

Fig. 2—Effect of pressure on catalyst activity and life (Cobalt-Thoria-Kieselguhr catalyst)

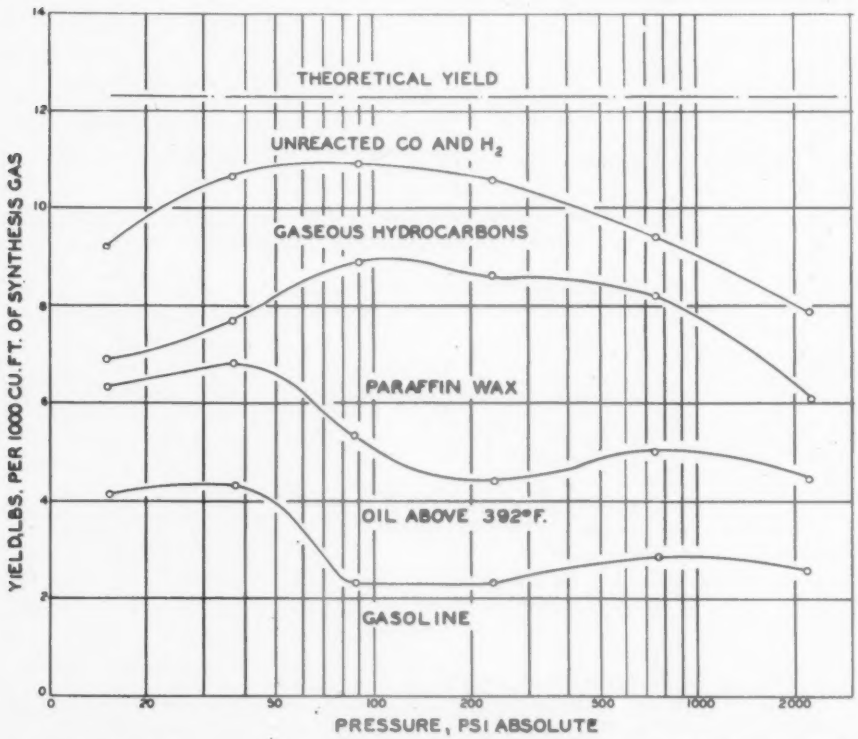

Fig. 1—Effect of pressure upon yields of hydrocarbons (Cobalt-Thoria-Kieselguhr catalyst)

In 1913 the Badische Anilin- und Sodafabrik[11] patented the conversion of mixtures of carbon monoxide and hydrogen into saturated and unsaturated gaseous and liquid hydrocarbons, alcohols, aldehydes, acids and ketones by catalytic treatment at elevated temperatures and pressures. Mixtures of two or more parts of carbon monoxide and one of hydrogen passed over a catalyst impregnated with alkali and oxides of cobalt, osmium or zinc, gave the above products at pressures of 1500 to 1800 psig and temperatures of 570-750° F.

In 1923 Franz Fischer and Hans Tropsch reported the reduction of carbon monoxide in the presence of alkali-iron catalysts at 750-840° F. and 1500-2200 psig.[12] The product was a mixture of aliphatic alcohols, aldehydes, ketones, acids and esters which was given the name of Synthol (derived from the German: *synthetisches oel*). Practically no hydrocarbons were found in this mixture (Table 2).[13] By heating Synthol at 842° F. for one hour, a mixture of hydrocarbons was received.

Later work showed that the yield of oxygen-containing compounds increased with increasing strength of alkali incorporated in the catalyst[14] (Table 3) and with decreasing ratio of hydrogen to carbon monoxide[15] (Table 4).

By a reversal of the conditions for increasing Synthol production (i.e., lower pressure, high hydrogen to carbon monoxide ratio, no alkali in catalyst), Fischer and Tropsch in 1926 converted mixtures of carbon monoxide and hydrogen to a product almost free from oxygen-containing compounds.[16] Iron or cobalt catalysts were employed at atmospheric pressure and 480-570° F. The product, con-

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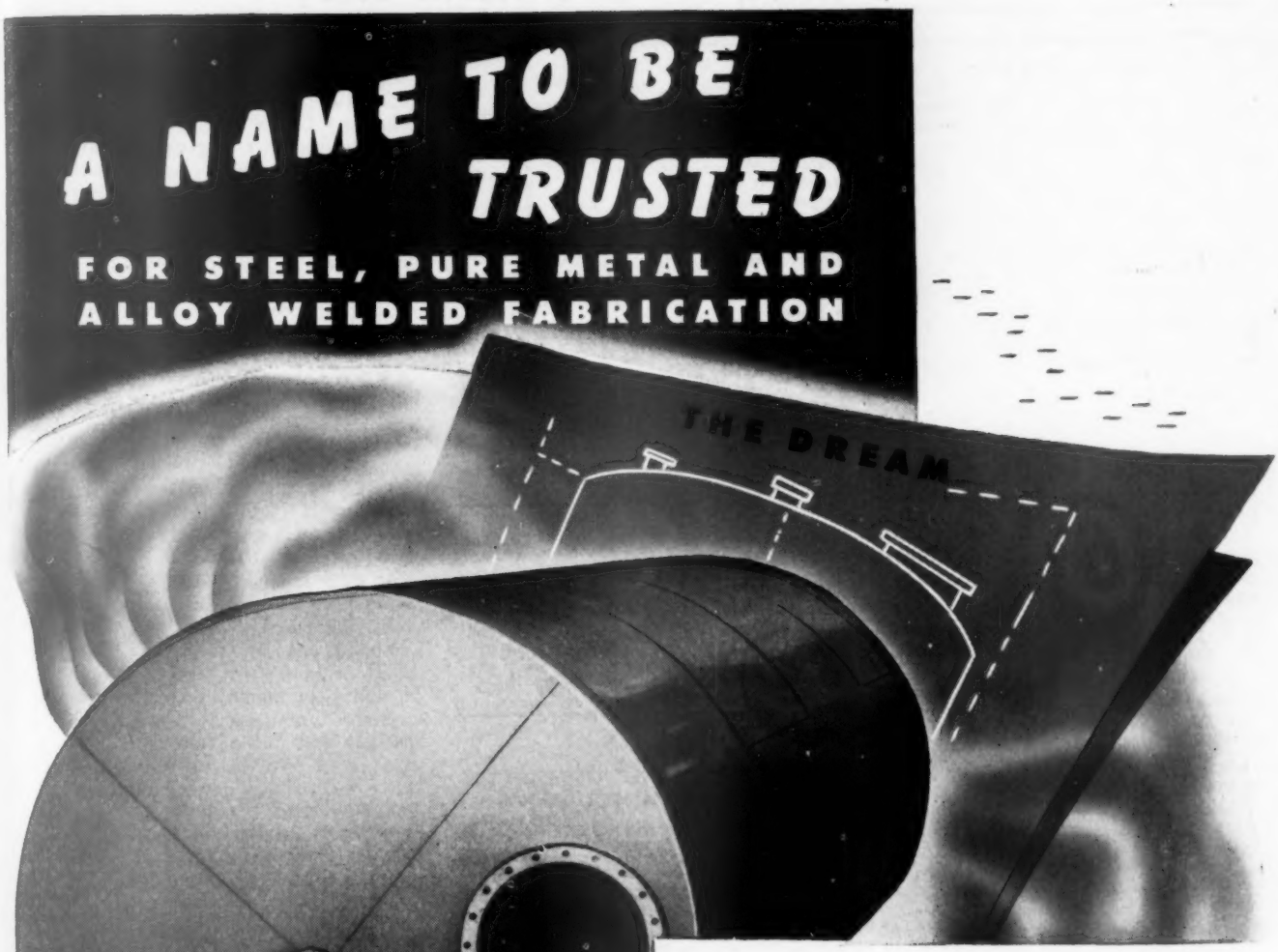

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TABLE 2
Composition of Synthol

Group	Fraction of total product, %	Identified	Approximate fraction of total product, %
Acids	10	Formic acid	0.1
		Acetic acid	2.3
		Propionic acid	2.1
		Isobutyric acid	1.0
		Higher acids (to C_8)	4.5
Water-soluble alcohols, aldehydes & ketones	29	Methyl alcohol	1.5
		Ethyl alcohol	14.5
		Propyl alcohol	
		Acetone	5.2
Partly miscible with water	11	Methyl ethyl ketone	
Oil volatile with steam	48	Propionic aldehyde	
		Isobutyric aldehyde	
		Di-ethyl ketone	
		Methyl-n-propyl ketone	
		Higher alcohols (to C_9)	15.0
		Esters	2.0
Oil not volatile with steam	2	Hydrocarbons	1.0

TABLE 3
Effect of Alkali Strength

Catalyst Composition (In order of increasing alkalinity)	Temp. °F	Pressure Gauge, psi	Yield, gal. per 1000 cu. ft.
Fe + LiOH	788	2075-1825	0 006
Fe + NaOH	788	2075-1780	0.07
Fe+KOH	788	2060-1910	0.28
Fe + RbOH	788	2060-1950	0.34

TABLE 4
Effect of H_2:CO Ratio

Ratio, H_2:CO	Temp. °F.	Pressure Gauge, psi	Yield*, gal. per 1000 cu. ft.
2:1	770	1800	0.12
1:1	770	1060	0.18
1:2	770	1400	0.23

*Includes estimated synthol content of the water layer

TABLE 5
Effect of Pressure Upon the Yields* of Hydrocarbon Products
(Yields expressed in lbs. of product per 1000 cu. ft. of gas at 60° F)

Pressure Gauge Psi	Total Solid and Liquid Hydrocarbons	Paraffin Wax	Oil above 392°F	Gasoline below 392°F	Gaseous Hydrocarbons (Including C_3 & C_4)
0	6.9	0.6	2.2	4.1	2.3
22	7.7	0.9	2.5	4.3	3.0
74	8.9	3.6	3.0	2.3	2.0
220	8.6	4.2	2.1	2.3	2.0
735	8.2	3.2	2.2	2.8	1.2
2205	6.1	1.6	2.0	2.5	1.8

*Yields are average of four weeks operation over cobalt-thoria-kieselguhr catalyst.

sisting largely of hydrocarbons ranging from ethane to solid paraffin wax, is known as Kogasin (a contraction of the German: *Kohle-Gas-Benzin*). The production of synthetic gasoline from water gas is known as the Kogasin synthesis, whereas Fischer-Tropsch synthesis is a somewhat more general term for the conversion of water gas to liquid products.

Later work (1932) showed that a nickel-manganese oxide-alumina-kieselguhr catalyst was superior to earlier cobalt catalysts for Kogasin synthesis at "normal" or atmospheric pressure.[17] Developments have since shown that a cobalt-thoria-kieselguhr (100:18:100) catalyst is the best catalyst for Kogasin synthesis. This catalyst is active at 350° F. and optimum activity is obtained at temperatures of 375-390° F.

By 1933 the Kogasin process had been successfully developed on a laboratory and pilot-plant scale. As a result, Ruhrchemie A.G. was able to construct a plant of 1000 tons per year capacity at Oberhausen-Holten.[18] The synthesis gas ($1CO:2H_2$), after removal of sulfur compounds (0.1 grain of sulfur per 100 cu. ft.), was passed over a nickel-alumina-manganese dioxide-kieselguhr catalyst at 375-410° F. and atmospheric pressure. Industrial progress was rapid until at the end of 1936 there were five plants in Germany with a total capacity of about 805,000 bbls. per year.[19]

The industrial progress of the Kogasin synthesis was accelerated by the discovery of the "middle-pressure" synthesis by Fischer and Pichler in 1936.[20] At pressures of 75 to 220 psig, an optimum yield of solid plus liquid hydrocarbons was received (Table 5, Fig. 1).[21] The chief advantage of this type of operation was that loss in catalyst activity was decreased. Whereas the yield dropped from 7.7 to 5.9 lbs. per 1000 cu. ft. in "normal-pressure" (atmospheric) synthesis in four weeks, the "middle-pressure" synthesis produced 8.9 lbs. initially and still was above 5.9 lbs. per 100 cu. ft. after 26 weeks of operation (Fig. 2). This synthesis has been performed with cobalt[20] and iron (1937)[22] catalysts; nickel catalysts deteriorate rapidly due to formation of nickel carbonyl at these pressures.

In 1938 the synthesis of high-melting wax on ruthenium catalysts at high pressures was reported.[23] In a study of certain metals of Group VIII of the periodic table (Ru, Rh, Pd, Os, Ir, Pt), ruthenium was found to produce solid hydrocarbons more effectively than any other metal of this group.[24] Thus, at 1500 psig pressure and 383° F., 5.9 lbs. of paraffin wax and 3.0 lbs. of oil were obtained per 1000 cu. ft. of gas ($2H_2$:1CO) with a ruthenium catalyst. No appreciable change in the activity of the catalyst occurred in a 6-months test. By solvent extraction of a solid paraffin obtained at 1500 psig pressure, a paraffin wax was obtained which had a melting point of 270-273° F. and a molecular weight of 23,000.[25]

The industrial progress of the Kogasin synthesis in Germany during 1933-40 was accompanied by developments in the utilization of the reaction products. The primary product is composed of

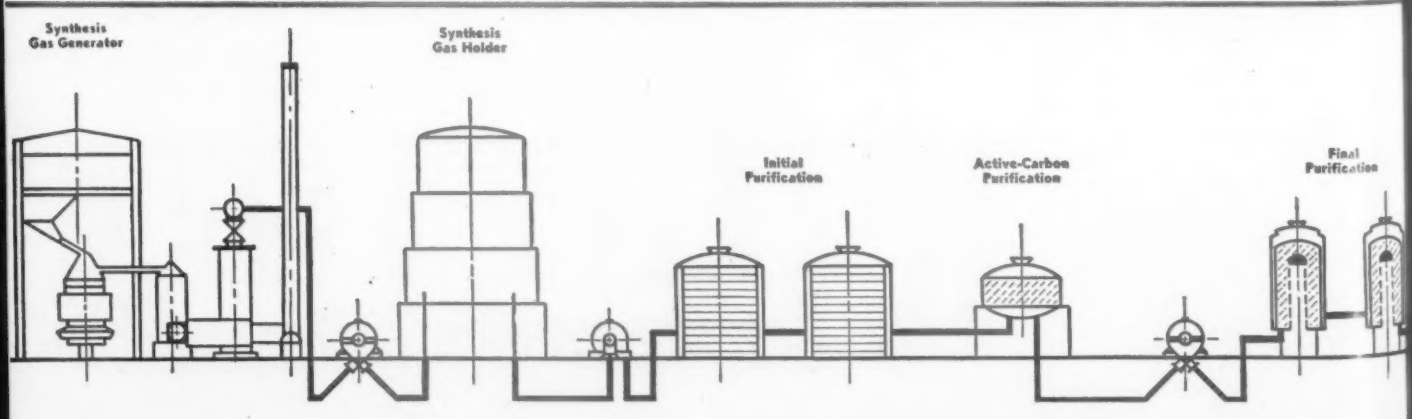


FIG. 4—FLOW DIAGRAM OF A TWO-STAGE PROCESS

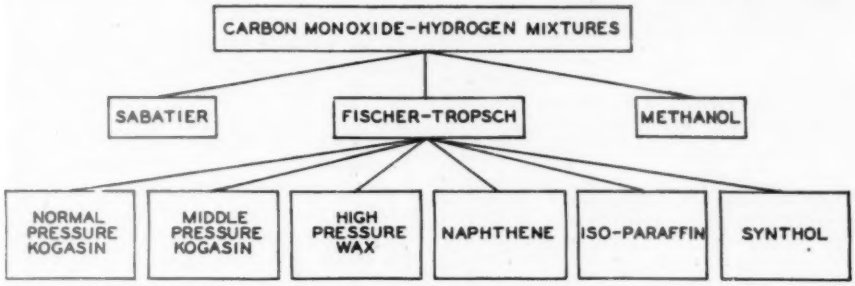


Fig. 3—Major developments of the Fischer-Tropsch synthesis and related processes

largely straight-chain paraffin and olefin hydrocarbons with only minor amounts of aromatics, naphthene hydrocarbons or oxygen-containing compounds. Table 6 presents data for the various fractions of the primary product when a cobalt catalyst was used.[26] The gasoline boiling up to 392° F. constitutes 60% of the total product. Because of the straight-chain nature of the hydrocarbons in the product, the gasoline fractions have low octane numbers. Thus, the octane number of the gasoline boiling in the aviation range (up to 302° F.) was only 55.

The octane number of the gasoline and the total yield of gasoline can be increased by reforming and cracking in conventional petroleum plant equipment. Thus, Egloff, Nelson and Morrell,[27] by means of thermal reforming and cracking and catalytic polymerization of the cracking gases, received 84.3% of 66-octane gasoline from a Kogasin oil which, originally, had an octane number of 20 (Table 7).

Diesel oil may be separated from the total Kogasin oil by simple distillation. It has a high cetane number due to the straight-chain character of the hydrocarbons contained in this fraction and is suitable for mixing with low-cetane-number oils.[28]

The paraffin wax produced in the synthesis is similar to the product received from petroleum and can be put to the same uses. Since 1936 catalytic oxidation of the synthetic wax has been used for the production of synthetic fatty acids. The product consists almost entirely of saturated normal fatty acids of both odd and even carbon number,[29] which are used for the manufacture of soap, cooking fats and artificial butter.[30]

The Kogasin product as such does not contain any lubricating oils. To meet this need, methods have been developed in Fischer's laboratory to produce synthetic lubricating oils. Among those which have been reported are (1) polymerization of fractions rich in olefins with aluminum chloride;[31] (2) chlorination of Kogasin fraction and polymerization without the addition of aromatics,[32] and (3) alkylation of aromatic hydrocarbons with chlorinated fractions, according to the Friedel-Crafts reaction.[33] Excellent viscosity properties (as shown by viscosity index of 90-100) are reported for these synthetic lubricating oils.[34]

TABLE 6

Composition of Kogasin

	% by weight	Olefins, vol. %
C_3- and C_4- hydrocarbons	8	55
Gasoline (to 302°F)	46	45
Naphtha (302-392°F)	14	25
Diesel oil	22	10
Paraffin wax from oil[a]	7	..
Paraffin wax from catalyst[b]	3	..

[a]Melting point, 122°F
[b]Melting point, 194°F

From the above historical development of the Fischer-Tropsch process, it may be seen that much work has been done by the Germans, particularly in Fischer's laboratory. This was due, in part, to the desire of Germany to obtain self-sufficiency in regard to petroleum products. However, many contributions to the synthesis have come from other countries. In Great Britain an experimental plant of 150 gals. per day has been erected to test the Robinson-Bindley process.[35] A smaller plant (4 gals. per day) has also been constructed by the Fuel Research Board.[36] The chief advantage of the Robinson-Bindley process is that it utilizes smaller hydrogen to carbon monoxide ratios than the Fischer-Tropsch synthesis.

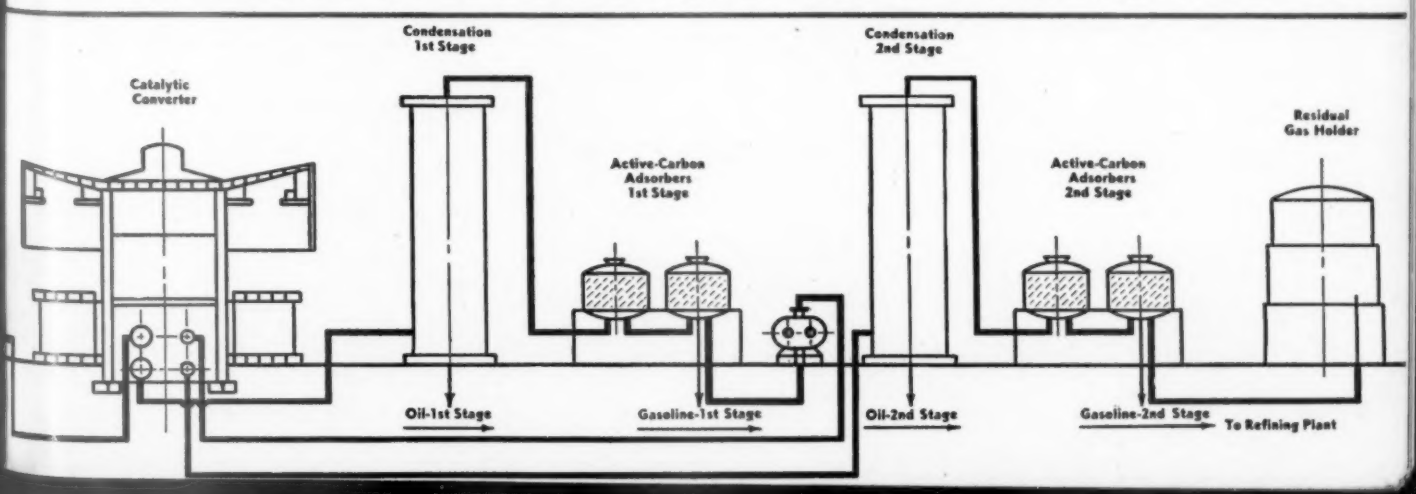
In Japan much work has been done by investigators there although no outstanding development has been disclosed.

In the United States, work has been done as early as 1928[37, 38] on the Fischer-Tropsch process. Smith, Hawk and Golden[39] found that the addition of ethylene to the synthesis gases produced large quantities of higher hydrocarbons and oxygen-containing compounds. This was an important discovery since it may help to clarify the reaction mechanism. The reaction will be discussed more fully under *Mechanism of the Reaction.*

Recent Developments

Since the start of World War II, two new syntheses have been announced, "naphthene synthesis" and "iso-synthesis".[22] Naturally details have not been disclosed. Both of these discoveries are due to the direction of the reaction towards the production of a specific class of hydrocarbons, e.g. in the naphthene synthesis, naphthenes and aromatics are produced. As noted above, only saturated and unsaturated straight-chain hydrocarbons are synthesized in the Kogasin synthesis. In the production of aviation gasoline, this is a serious objection because of the low octane number of the product. However, by means of the "iso-synthesis", it is implied that iso-paraffins are produced directly and that the gasoline fractions would have high octane numbers. The C_4-fraction from the process contains 90% of iso-butane.[22] This, in itself, is important, since by converting half of the iso-butane to iso-butene (by dehydrogenation) and alkylation of the remaining iso-butane with the iso-butene produced, 100-octane aviation gasoline could be produced.

The major developments of the Fischer-Tropsch synthesis and two allied processes are shown in Fig. 3 to summarize the main uses of carbon monoxide-hydrogen mixtures. The Sabatier synthesis of methane is included to emphasize the close relationship between it and the Kogasin synthesis, the synthesis of methanol and synthol are related in a somewhat similar manner. Storch[19] estimates that the present yearly production in Germany is 5,590,000 bbls. of gasoline, Diesel oil, lubricating oil and paraffin wax. A recently published flow chart of



the Fischer-Tropsch process is presented in Fig. 4.[40]

Difficulties Encountered in Fischer-Tropsch Synthesis

While there are many problems involved in the production of hydrocarbons from carbon monoxide and hydrogen, three are worthy of particular mention.

First, there is the requirement that the synthesis gas be composed of hydrogen and carbon monoxide in the ratio of 2:1 for the industrially developed cobalt catalysts. This is occasioned by the nature of the reaction (Equation 1). Processes have been developed which can produce synthesis gas from a wide variety of materials.[41] The production of synthesis gas from natural gas by means of steam gives a ratio of 3:1, i.e.,

$$CH_4 + H_2O \longrightarrow CO + 3H_2 \quad \ldots (6)$$

The use of carbon dioxide (Equation 2) or oxygen (Equation 3) produces gases of the proper composition.

A second problem is the removal of the heat of reaction. With cobalt or nickel catalysts the reaction is[42],

$$CO + 2H_2 \longrightarrow (CH_2) + H_2O + 79{,}200 \text{ Btu/lb-mol} \quad (7)$$

while for iron catalysts, the reaction is[42],

$$2CO + H_2 \longrightarrow (CH_2) + CO_2 + 78{,}700 \text{ Btu/lb-mol} \quad (8)$$

Since the reaction is very sensitive to temperature, the optimum temperature must be rigidly maintained within 9-18° F. throughout all parts of the catalyst zone. These difficulties have been largely overcome by proper reactor design.

The third difficulty, which has proved a considerable obstacle to the progress of the synthesis, is the requirement that the synthesis gas contain no sulfur. The upper limit of sulfur concentration which can be tolerated by the active catalyst is approximately 0.1 grain per 100 cu. ft. The problem can be solved in one of two ways: (a) by means of desulfurization or (b) by developing a sulfur-resistant catalyst. The first method has been used almost exclusively since a sufficiently active sulfur-resistant catalyst has not yet been developed.

TABLE 7

Processing of Kogasin to Produce Gasoline

	Yield[a] vol.-%
Light gasoline[b]	29.1
Reformed gasoline from naphtha[c]	26.8
Cracked gasoline from bottoms	22.6
Polymer gasoline	5.8
	84.3

Octane number of blend of all gasolines, 66.
[a]Based on Kogasin oil charged; original octane number was 20.
[b]Octane number of 97-241°F fraction was 68.
[c]Octane number of the 219-523°F fraction before reforming was 4.

Mechanism of the Reaction

Fischer and Tropsch[16] proposed that the first step in the synthesis was the formation of carbides with the metal of the catalyst. The second step was the reduction by hydrogen of the carbide to form methylene radicals. The final step was the polymerization of the radicals to form hydrocarbons other than methane.

Since carbide formation on the catalyst has been always associated with the production of liquid hydrocarbons[43], it seems logical that any mechanism proposed must take this fact into account. Thus, reduction of Fischer-Tropsch carbides with hydrogen as well as acid decomposition leads to higher hydrocarbon formation. Hence, it seems likely that carbide formation is a necessary initial step in the reaction mechanism. While the mechanism proposed by Fischer and Tropsch includes carbide formation, it fails to explain adequately some of the other features of the reaction.

Craxford[44, 45] has developed a mechanism which is satisfactory in many respects. The first step is the reaction of both carbon monoxide and hydrogen to form carbide.

$$2Co + CO + H_2 \longrightarrow Co_2C + H_2O \quad \ldots (9)$$

This reaction is faster than the reduction of carbide by hydrogen under the synthesis conditions (Steps I and II, Fig. 5). Therefore, carbides can be built up on the catalyst during the early stages of synthesis. In the next step, the carbide is reduced by molecular hydrogen to form a surface methylene (Step III). Craxford found a parallelism between ortho-para hydrogen conversion and methane formation in all cases investigated. Thus, when methane was the main product of the hydrocarbon synthesis, the ortho-para hydrocarbon conversion was high, an indication of the presence of chemisorbed hydrogen. Alternately, if the catalyst was producing liquid hydrocarbons, the ortho-para hydrogen conversion was inhibited, or very little chemisorbed hydrogen was present on the catalyst surface. Therefore, it is postulated that in the presence of a large amount of chemisorbed hydrogen, methane is evolved from the reaction (Step IV a, Fig. 5). In the presence of smaller amounts of chemisorbed hydrogen, the reduction of the carbide occurs with molecular hydrogen to produce liquid hydrocarbons.

$$nCo_2C + nH_2 \longrightarrow (CH_2)_n + 2_nCo \quad \ldots (10)$$

This step may take place through the formation of macro-molecules on the catalyst surface (Step IV b, Fig. 5). The release of paraffin or olefin hydrocarbons depends upon the prevailing synthesis conditions, ie., hydrogen-carbon monoxide ratio, catalyst, temperature and pressure. While the Craxford mechanism is valuable, it is, nevertheless, complicated and, so far, limited to cobalt catalysts.

Basing their conclusions on experimental observations with cobalt catalysts, Herington and Woodward[46] take the view that a cobalt catalyst possesses active centers of two types: Type A (probably cobalt carbide), which is responsible for the formation and polymerization of methylene groups; and Type B (probably cobalt metal), which causes liberation of the products observed. When Type B centers predominate, only gaseous products are formed; when Type A centers predominate, liquid products are formed. This mechanism is simpler than the Craxford mechanism but also is limited in application to cobalt catalysts.

It is our suggestion that the catalyst surface, and, more particularly, the composition of the catalyst, has a large influence on the reaction mechanism. Thus, it seems evident in a broad sense that on the catalyst surface two separate influences are present,

a. hydrogenating effect
b. polymerization effect

Thus, carbon monoxide molecules are reduced to methylene groups which, in turn, are polymerized to higher hydrocarbons. The initial step in the reaction is the formation of carbide with the metal of the catalyst surface. This step requires that the catalyst contain a metal which is capable of forming a carbide. The second step is the reduction of car-

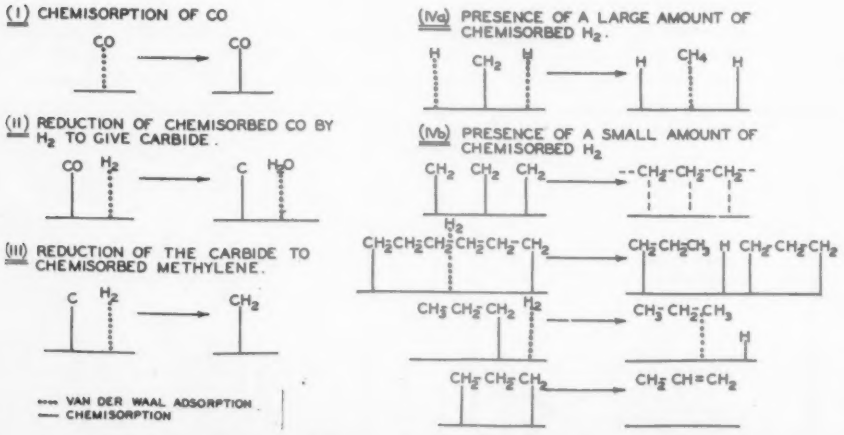
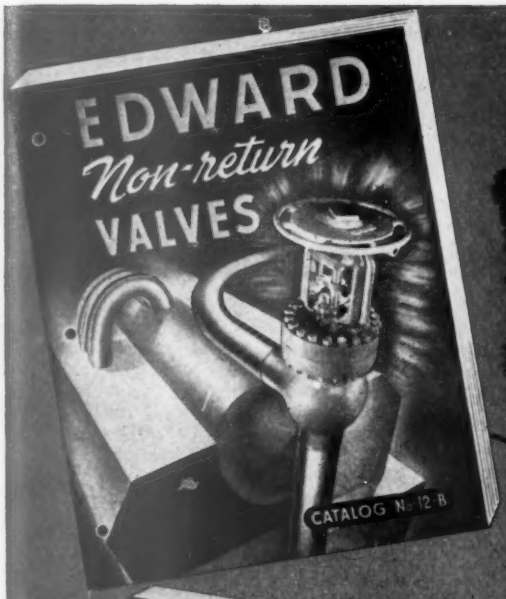
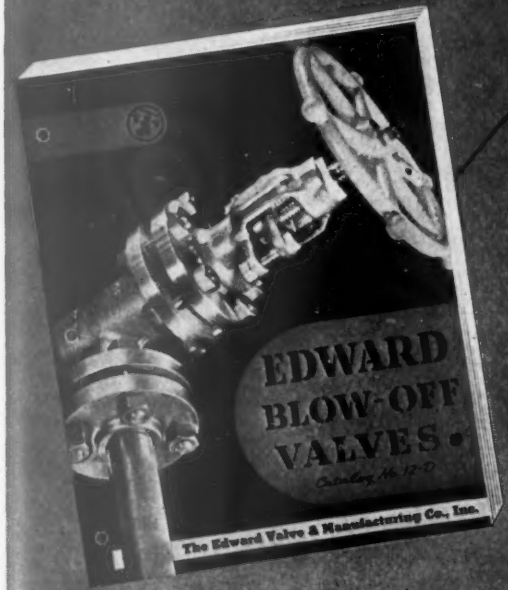

(I) CHEMISORPTION OF CO
(II) REDUCTION OF CHEMISORBED CO BY H2 TO GIVE CARBIDE.
(III) REDUCTION OF THE CARBIDE TO CHEMISORBED METHYLENE.
(IVa) PRESENCE OF A LARGE AMOUNT OF CHEMISORBED H2.
(IVb) PRESENCE OF A SMALL AMOUNT OF CHEMISORBED H2
VAN DER WAAL ADSORPTION
CHEMISORPTION

Fig. 5—Mechanism of the synthesis of hydrocarbons (Craxford)





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bide on the catalyst surface; hence, a hydrogenating catalyst is required. Finally, the third step involves the polymerization of the methylene groups and indicates that the presence of a polymerizing catalyst would be advantageous. Consequently, the catalyst must comply with the following conditions.

1. Ability to form a carbide from carbon monoxide
2. Hydrogenating ability
3. Polymerizing ability

Certain metals of the 8th group, i.e. nickel, cobalt and iron, fulfill the requirement of forming carbides of suitable stability. These metals also possess hydrogenating ability and thus satisfy condition 2. However, if pure nickel, for example, is used, only methane is formed and hydropolymerization to produce liquid products does not occur. Therefore, the hydrogenating effect must be decreased by supporting nickel on a carrier (kieselguhr) and polymerization reactions enhanced by the addition of other ingredients in order to produce higher hydrocarbons.

While under certain conditions a catalyst composed of one element would fulfill all three of the postulated requirements, practically, a multi-component or "complex-action" catalyst[47] is required. The idea of "complex-action" catalysts has been used to describe the action of certain catalysts which produced, for example, hydropolymerization of iso-butene to iso-octane[48] and dehydropolymerization of ethylene.[49] If it is accepted that the Fischer-Tropsch reaction occurs through the use of a "complex-action" catalyst it narrows the selection of catalysts to *direct t*he Fischer-Tropsch synthesis into producing hydrocarbons of desired size and structure.

Many of the phenomena observed during the reaction can be explained on the basis outlined. Thus, the necessity for complete sulfur removal may be caused by the fact that the hydrogenating portion of the catalyst is readily poisoned by sulfur, thereby stopping the initial reduction of carbide. However, Herington and Woodward[46] found that the initial effect of adding hydrogen sulfide to the synthesis gas was to increase the yield of heavier oils while the production of lighter hydrocarbons diminished. The total effect for small quantities of sulfur may be an increase in yield as reported by other workers.[50] Since the polymerizing active centers would be relatively unaffected while the hydrogenating centers were poisoned by sulfur, it might be expected that, initially, the yield of heavier oils might increase at the expense of the lighter hydrocarbon yield. The addition of further quantities of sulfur, however, destroys the hydrogenating influence of the catalyst and thereby stops all reaction.

Fischer and Pichler[21] attribute the increased time of high catalyst activity in the "middle-pressure" synthesis to the fact that certain poisons, perhaps oxygen-containing compounds are hydrogenated and rendered innocuous under these conditions (75-220 psig). This speculation may be correct. However, whether the poisoning is due to certain oxygen compounds or not, it should be pointed out that, in general, increased pressure reduces the sensitivity of hydrogenation catalysts to poisoning. Therefore, it might be anticipated that in the synthesis of hydrocarbons over a hydrogenation-polymerization catalyst, susceptibility to poisoning of the hydrogenating portion would be reduced at higher pressures and would lead to long periods of high catalyst activity.

Smith, Hawk and Golden[39] found that when ethylene was added to the synthesis gas, large quantities of higher hydrocarbons and oxygen-containing compounds were formed over a cobalt-base catalyst. These facts are explainable by noting that while the relationship between the hydrogenating and polymerizing portions of the catalyst remained constant, ethylene, being strongly adsorbed and highly reactive, combined with methylene on the catalyst surface as well as reacted with carbon monoxide (under the influence of the polymerizing portion of the catalyst). The hydrogenating influence remained constant and had a smaller influence on the nature of the products. Ethylene alone or in admixture with either carbon monoxide or hydrogen did not form higher hydrocarbons under the same conditions. With an iron-base catalyst, ethylene did not give the same reaction. It may be possible that ethylene is not sufficiently adsorbed on this particular catalyst.

In general the mechanism of the reaction over an iron catalyst appears to be quite different that that over cobalt or nickel catalysts. Storch[51] has enumerated and discussed these facts recently. While the published work on iron catalysts is rather incomplete, it is believed that the "complex-action" idea can be applied advantageously in this instance also.

In summary, recognition of the necessity of finding a "complex-action" catalyst which combines both hydrogenating and polymerizing properties should narrow the search for catalysts which direct the Fischer-Tropsch synthesis into specific desirable reaction products.

Conclusions

Development of the Fischer-Tropsch synthesis will add to national security. The utilization of the process to convert natural gas to gasoline is probably economical now in certain areas. Future research developments may lead to a broad application in the production of high-quality liquid fuels.

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Synthetic Aviation and Motor Oils Seen as Future Developments*

WE HAVE probably closely approached the upper limit in quality of aviation oils that can be provided through selection of the crude source, stated Dr. F. L. Miller, assistant director of Esso Laboratories of Standard Oil Development Co., at the opening of the new aviation fuel testing laboratory at Bayway, N. J.

Improved performance characteristics of these types of oils will have to be obtained by other means, he said. One such means is through the use of certain types of synthetic commercial additives.

Another possible method he gave is through the development of aviation oils partly or wholly synthetic in nature. Such products have been prepared, said Dr. Miller, utilizing low molecular weight olefins, cracked wax olefins, or other materials, and their performance has been such as to warrant further work along this line.

Improvements in aviation oils which made possible the increasing of the period between engine overhauls would add materially to the incremental value of the oil to the operator, he stated. This would make it economic for operators to pay a sufficiently higher price for their oils to compensate refiners for the increased manufacturing costs.

Following is a review of a paper entitled "Aviation Engine Lubricants", prepared by Dr. Miller and issued by the company in connection with the opening of the new laboratory:

Until less than five years before the entry of the U. S. into World War II, the country was essentially limited to a single type crude, Pennsylvania, for its aviation lubricants. Were the country still dependent on this one source of aviation oil, the aerial war would be seriously handicapped, even if supplies of quality lubricating oils for commercial and civilian purposes were sharply curtailed.

Solvent Treating Methods Developed

Fortunately the development of new solvent treating techniques and their general application in the petroleum industry have made possible the production of oils, not only of equal or superior quality, as compared to the Pennsylvania oils, but also in extremely large volume so that the war effort has been supported without any significant sacrifice in either the quality or the supply of lubricants on the home front.

The Jersey Company early recognized the high level of quality which was needed in aviation engine lubricants and the possibility of applying the newer refining methods in obtaining this quality. To this end, an extensive program of full-scale engine tests was started in 1936 under a contract with the Pratt & Whitney Co., utilizing their equipment and some of their personnel. This program, the only one of its kind undertaken in this country, provided an excellent background of information about lubricating oil performance characteristics and demonstrated that definite differences in the quality of aviation lubricating oils existed and could be determined with a reasonable degree of certainty.

More Crudes Can Be Used

It further demonstrated that with the new propane solvent treating techniques developed by the Jersey Company good quality aviation oils could probably be made from many crudes, some of them previously considered unsatisfactory for lubricating oil manufacture, and that outstanding products could be made from certain selected crudes.

By the time the war intervened in 1939, the program had resulted in the development of an oil solvent extracted from Mid-Continent crude of especially high quality. It received an excellent rating on the official approval tests performed by the Wright Aeronautical Co. and performed excellently in all other engine approval tests to which it had to be submitted. Its performance in actual service has been equally as excellent as that shown in the different full-scale engine tests.

Even Better Oils Needed

It is becoming evident, however, that —as good as some of the present oils are, —there will be a need for oils showing even better performance in the future. Already difficulties with ring sticking, increased sludge, etc., are being encountered with the oils now generally available. This is particularly true with the latest and most powerful engines, especially under combat conditions where severity of operation is much greater than ever before. Furthermore, with oils of high enough quality certain mechanical changes in the engine to improve operations might be permitted.

For example, one possibility would be the reduction of cooling area to improve utilization of the engine's power. It has been estimated by aeronautical engineers that the useful power could perhaps be increased around 15% at high altitudes, less at lower altitudes, by allowing the cylinder temperatures to increase 50°F. All of the difficulties such as sludge deposits, ring sticking, etc., naturally become greatly aggravated under these more severe conditions and demand the utmost stability and performance in the oil.

Extensive research, including small single cylinder and full-scale engine tests

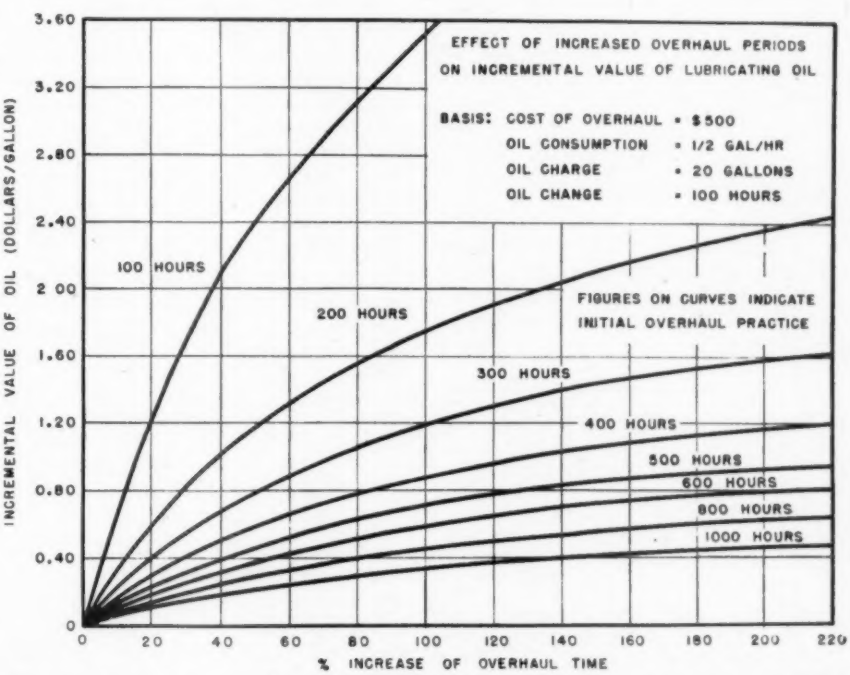


Fig. 1—Effect of increased overhaul periods on the incremental value of lubricating oil

*Review of a paper entitled "Aviation Engine Lubricants" by Dr. F. L. Miller, Assistant Director, Esso Laboratories, Standard Oil Development Co.

and flight tests will be necessary to determine what special qualities are needed in these new oils and how to obtain them. The work which has already been done indicates that significant improvements are possible. The available evidence, however, indicates that we have probably closely approached the upper limit in the quality that can be provided through selection of crude source and method of refining, and that the improved performance characteristics will have to be obtained by other means.

One means of obtaining the superior performance will undoubtedly be the use of small quantities of certain types of synthetic commercial additives. Some of these, particularly the detergent type additives, have been widely adopted for the manufacture of heavy duty motor oils such as those used by the Armed Forces, and have shown unusual ability to prevent ring sticking and to maintain engine cleanliness. Numerous full-scale engine tests on several different kinds of engines and extensive flight tests of over 250,000 hours in commercial airlines and in combat ships have further confirmed the excellent performance, particularly with regard to ring sticking and ring zone condition, of the oils containing this additive.

Another possible method of obtaining the desired improved qualities may be through the development of oils which are partly or wholly synthetic in nature. Several such products, utilizing low molecular weight olefins, cracked wax olefins, or even distinctly novel raw materials, have been made and some have shown a certain degree of promise. One made a number of years ago by the polymerization of cracked wax was offered commercially for a time and was tested rather extensively. A second material which has shown promise is the voltolized fatty oil concentrate which was used rather widely in some parts of Europe prior to the present war. It is rumored that the Germans are using synthetic oils in their aircraft and voltol oils in their ground vehicles if not in aircraft.

However they are obtained, these better performance qualities should be of distinct value to the aircraft industry. First, they should permit the development of even more powerful engines or operation under more severe conditions or both. This would be of importance to both military and commercial aviation. Second, they should offer greater resistance to ring sticking, which is more common in certain European engines than in American, and to sludge formation. To military aviation this should at least offer greater reliability of operation. To commercial aviation it should permit longer periods between relatively costly overhauls. Presently, overhaul periods are predicated on one or more of the following factors:

(1) Ring and cylinder wear
(2) Ring sticking
(3) Sludge accumulation

Overhaul Periods Lengthened

In many cases, particularly in American commercial airlines, continued improvement in the engines and the lubricating oils have combined to raise the overhaul periods to as high as 500 to 600 or more hours. The K.L.M. lines in Europe were reported, prior to the war, to be above 750 hours employing a Voltol blend. Nevertheless, rather large differences still exist as evidenced by the sharply contrasting situation which exists in two large international airlines. One line, employing engines relatively free from ring sticking tendencies and a high quality lubricating oil, has succeeded in reaching overhaul periods in the neighborhood of 600 hours and is aiming at still longer times with a likelihood of success.

The second, with engines more likely to stick rings and with an oil of average competitive quality is forced to overhaul its engines at around 200 hours. An improvement in oil quality that would permit the second operator to double his overhaul time should have an incremental value to him upwards of $1.60 per gallon of oil purchased (See Fig. 1), assuming average oil consumption, oil change practices, oil prices and engine overhaul costs. Similarly, an extension of the overhaul period to 1000 hours from 600 hours should have an incremental advantage of around 47c a gallon to the first operator. If oil changes could also be eliminated another 7c a gallon would be added to the oil's value.

There are numerous other lubricating oil problems in the aircraft field which are receiving a great deal of attention and research effort. Among the most important of these are:

(1) High V. I. hydraulic oils
(2) Special lubricants for instruments and aircraft accessories
(3) Rust preventives and rust preventive engine oils
(4) Special greases
(5) Gear lubricants

All of these occupy a prominent place in the operation and maintenance of aircraft, and quality is equally as important a consideration to them as it is in the case of the fuels and engine lubricants.

Postwar Fuels

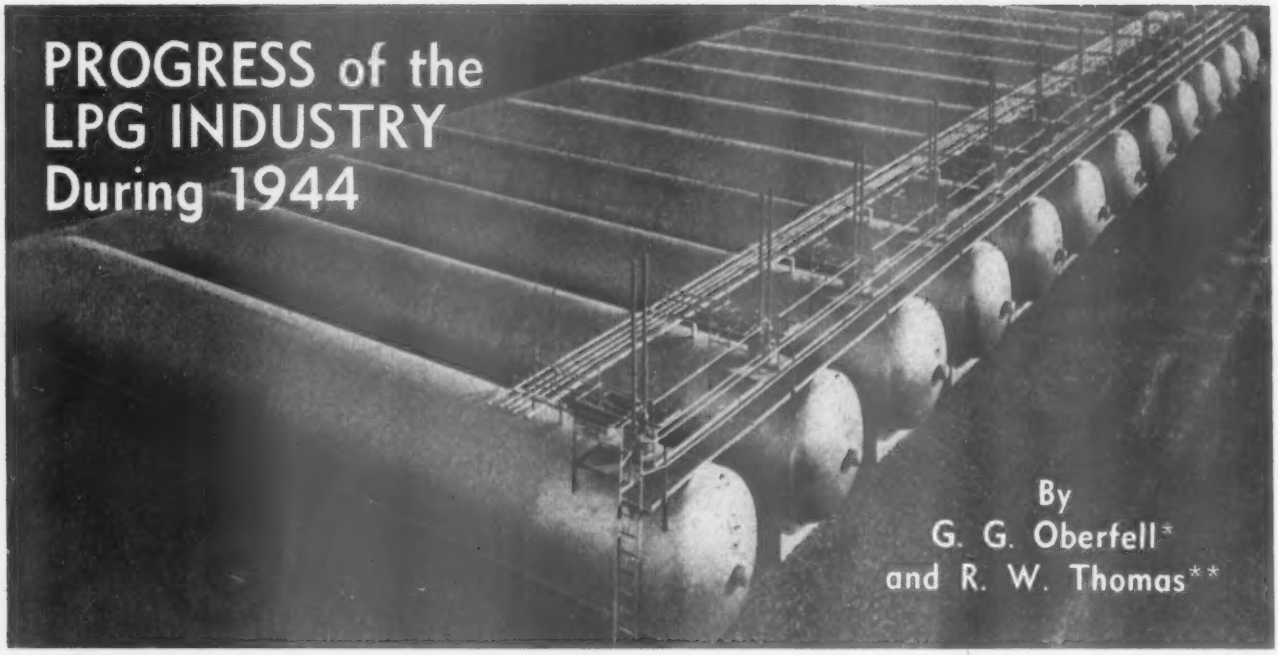
In response to numerous requests, reprints of the article "Postwar Internal Combustion Engines and their Fuels" by T. B. Rendel, which appeared in the January 3 issue of the Technical Section (*pgs. R-66—75*), have now been made available.

Readers may obtain copies, without charge, from the Technical Editor, National Petroleum News, 1213 West Third St., Cleveland 13.

Vapor recovery and fractionating plant in an East Coast refinery, designed and constructed by Petroleum Engineering, Inc. Offices: Tulsa and Houston.

Photographed for Petroleum Engineering, Inc.
By Robert Yarnall Richie

PROGRESS of the LPG INDUSTRY During 1944



By G. G. Oberfell* and R. W. Thomas**

Battery of industrial propane tanks with an aggregate capacity of 288,000 gals. at the Kohler Co., Kohler, Wisc.

The consumption of liquefied petroleum gas (LPG) in many markets continued to expand in 1944, aside from the two chief wartime uses in the manufacture of aviation gasoline and synthetic rubber. Under wartime conditions the trend toward the use of propane, in place of butane, by large industrial and utility consumers has been accentuated. Many distributors in their postwar expansion are planning to install 200-lb. working pressure storage, so they can distribute propane, butane or mixtures as market conditions dictate.

As the volume consumption of LPG increases year by year, the greater becomes the strain on the industry's transportation facilities during the winter period of peak demand. The need is recognized, to relieve this burden, for sufficient storage on consumers' premises to carry them through 6 to 8 weeks of the winter season.

MARKETED production of liquefied petroleum gases for other uses than synthetic rubber and aviation gasoline is estimated to have increased 110,000,000 gals. or 16.2% in 1944 to 785,000,000 gals. The estimated increase for LPG purposes was 20,000,000 gals. larger in volume than the increase shown the previous year.

Household (domestic) demand for LPG is estimated to have increased 53,000,000 gals. or 15.5% in 1944 to 392,000,000 gals. In 1943 the increase in household (domestic) consumption was 39,821,000 gals. or 13.3% and in 1942 it was 78,837,000 gals. or 35.7%. Wartime restrictions kept new installations at a low level but there was a considerable amount of shifting of equipment from summer cottages and similar seasonal dwelling to the homes of year-around users. Demand for LPG also was greater from existing consumers because of economic conditions.

It is estimated there were 1,950,000 domestic users of LPG on Dec. 31, 1944, an increase of 50,000 during the year. Buried butane installations in the south increased an estimated 16,000 in 1944 to 335,000 and all other types of domestic installations are estimated to have increased 34,000 to 1,615,000.

Industrial fuel, internal combustion engine fuel and miscellaneous uses of LPG rose an estimated 44,000,000 gals. or 18.1% in 1944 compared with an expansion in demand of 41,501,000 gals. or 20.6% in 1943. Most of the increase in industrial fuel use may be attributed to the fact that war plant consumers of LPG were operating during the entire year of 1944, whereas many of these plants did not begin operating until the middle or latter part of 1943. The relatively minor war contract cancellations and cut-backs near the close of the year did not materially affect the industry; moreover these contract reductions and cancellations came at a time when the normal seasonal use curve was rising.

City gas plants are estimated to have consumed 46,000,000 gals. of LPG in 1944, an increase of 22.6% over 1943.

***The Authors . . .**

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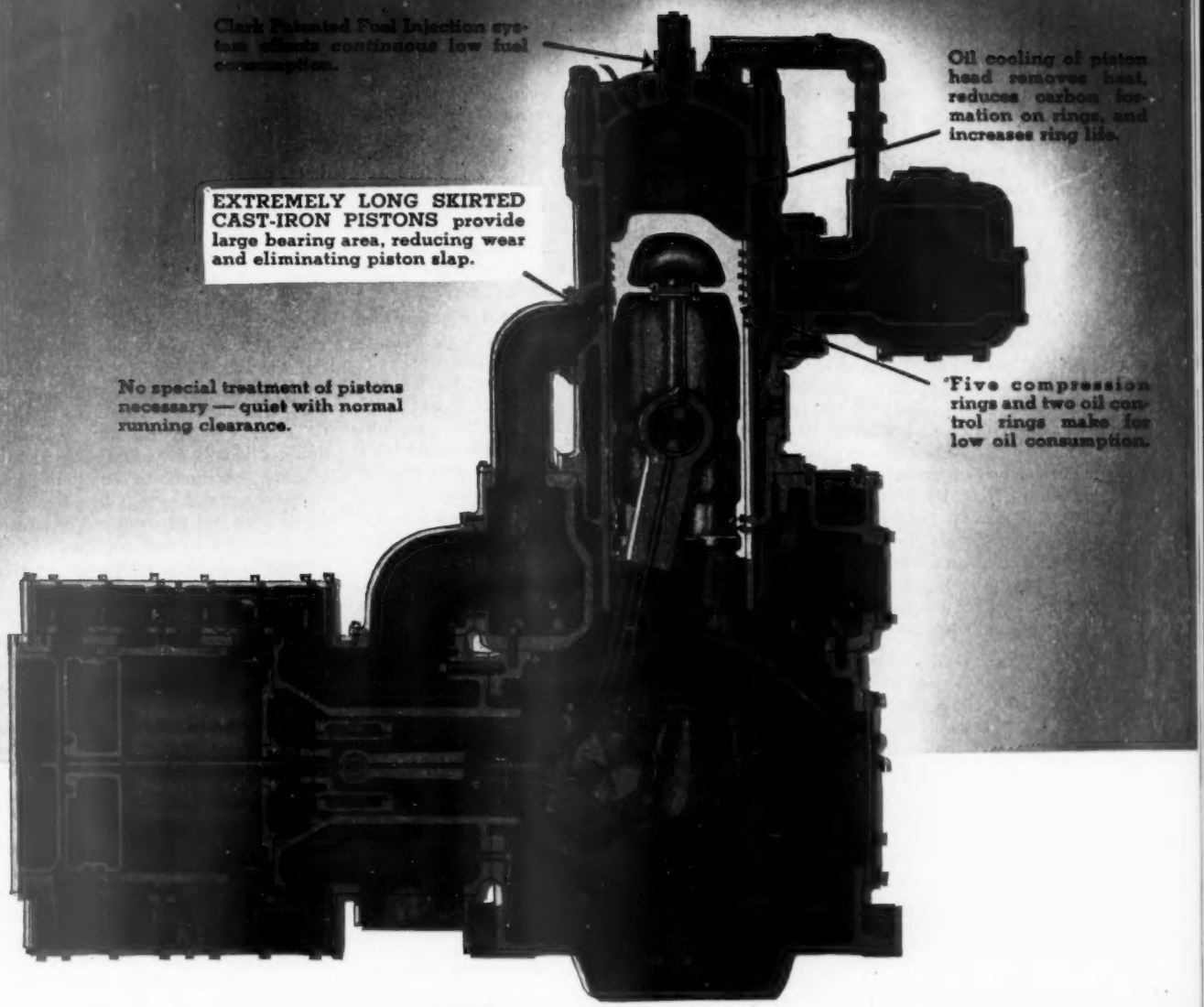
Clark Patented Fuel Injection system effects continuous low fuel consumption.
Oil cooling of piston head removes heat, reduces carbon formation on rings, and increases ring life.
EXTREMELY LONG SKIRTED CAST-IRON PISTONS provide large bearing area, reducing wear and eliminating piston slap.
No special treatment of pistons necessary — quiet with normal running clearance.
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This increase was greater than the 19.6% increase in 1943 largely because of the use of LPG for cold enrichment and underfiring of coke ovens in several large cities.

One city gas plant stored LPG at low pressure in undiluted form. No high pressure liquid storage tanks were available so the company allocated a 3,000,000-cu. ft. gas holder to butane and propane storage. As tank cars were received the butane or propane was vaporized in a conventional heat exchanger and undiluted vapor pumped into the holder at 6 ins. water column pressure. The gas holder acted as a standby from which gas was withdrawn at peak load periods, diluted and added to the send-out stream. By storing 3200 Btu butane vapor instead of 530 Btu gas the capacity of the holder was expanded in effect from 3,000,000 to 18,000,000 cu. ft. of 530 Btu gas. At present the holder is being used for the storage of undiluted propane vapor. This is because butane is unavailable now in adequate quantities because of war demands for aviation gasoline and synthetic rubber components.

Utilization of LPG for chemical manufacturing is estimated to have increased about 5,000,000 gals. in 1944 to 60,000,000 gals. Chemical sales represented 7.7% of total LPG utilization, compared with 8.2% in 1943 and 9% in 1942. These figures do not, of course, include normal butane or butenes used in the production of butadiene for synthetic rubber. No estimate is included to cover natural isobutane or normal butane isomerized by catalytic processes to isobutane, or C_3 and C_4 unsaturates produced by cracking and alkylated with isobutane for the production of 100 octane aviation fuel.

For several years the trend in the LPG industry has been in the direction of a more rapid increase in propane than in butane consumption. War-time demands for butane accelerated this trend in 1944. In 1942 marketed production of butane and butane-propane mixtures in which butane predominates, increased 98,981,000 gals. while propane sales increased 23,542,000 gals. Propane represented 19% of this total increase.

In 1943 the war almost reversed the situation so that butane and butane-propane mixture sales increased only 22,328,000 gals. and propane sales 67,762,000 gals. Propane represented 75% of this total increase. In the year just closed it is estimated that there has been no substantial increase in the sale of butane and mixtures and it may be predicted that in 1945 the sale of butane and mixtures will be reduced materially. This will be due primarily to conversion of large scale industrial and utility consumers of butane to propane.

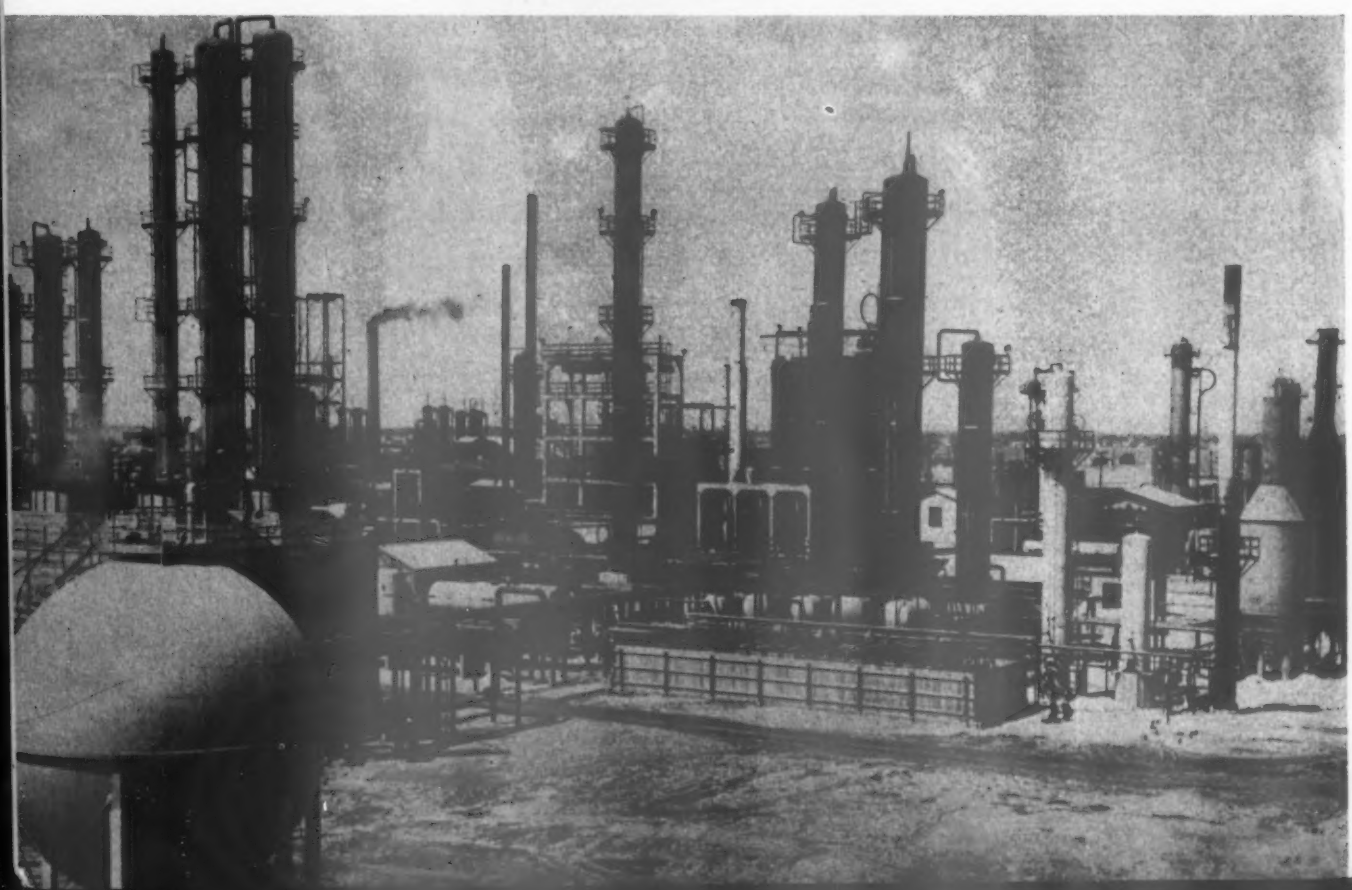
The Petroleum Administration for War announced at midyear that aviation gasoline production had reached 16,800,000 gals. daily and in the fourth quarter the completion of other 100 octane plants increased this total to more than 21,000,000 gals. daily.

With the synthetic rubber construction program completed and producing at the rate of 350,000 tons per year of buna and butyl rubber from petroleum hydrocarbons, this war industry is requiring an estimated 765,000 gals. daily of C_4 hydrocarbons.

The large number of gallons per day of C_4 hydrocarbons now used by rubber and aviation gasoline suggests that there will be a tremendous over-supply of butane for LPG once the Pacific war is over. It should be remembered, however, that the oil refining industry has been robbing motor fuel of volatility in order to feed the modern war machines in the same way that the LPG industry has limited its sales to make butane available to fight the enemies of our country. When the war is over gasoline quality for civilians will be improved. Also it is probable that war-developed techniques of C_4 utilization in aviation gasoline undoubtedly will be adapted to peacetime gasoline production. Aviation gasoline demand will not be significant when compared with war demand but at least some alkylation plants will consume very large quantities of butanes in the production of automobile gasolines of higher quality.

There has been a great deal of discussion in the industry about chemical utilization of LPG hydrocarbons. This outlet for LPG will, of course, be more important after the war than it is today; but the volumes which will be used in chemical synthesis at competitive prices are not great enough to be a threat to the supply of C_4 and C_3 hydrocarbons for domestic and industrial use.

During the past year one chemical manufacturer has been building a large plant in the lower Gulf Coast region which will take propane and butane by pipeline from a group of gasoline and recycle plants in the vicinity. Before the

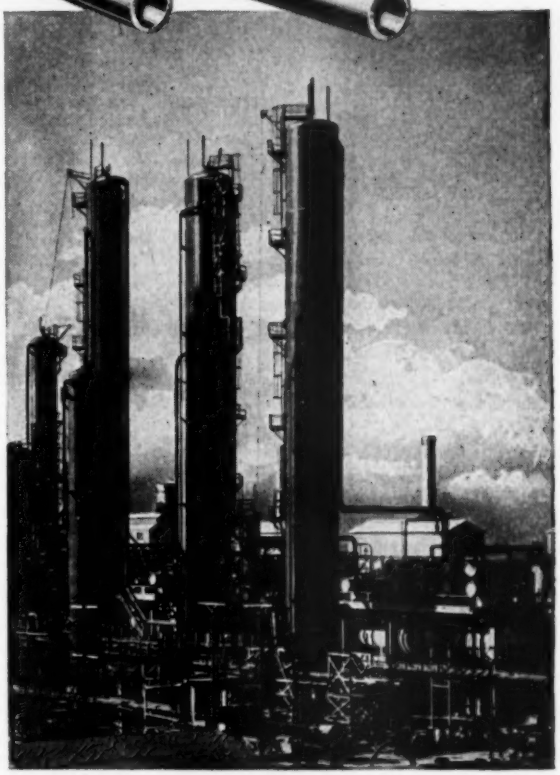


Butane isomerization and hydrogen fluoride alkylation plant for the production of aviation gasoline and synthetic rubber components in a modern refinery

for HIGH TUBING ECONOMIES in HIGH TEMPERATURE, HIGH PRESSURE service

Many refineries, synthetic rubber plants, and chemical plants are taking advantage of B&W low and intermediate alloy steel seamless tubing for applications requiring resistance to high temperatures, high pressures, and corrosion. The key to successful application of this tubing is in the choice of the correct alloys for given conditions. For example, B&W Croloy tubes are today serving satisfactorily and economically in the production of 100-octane aviation gasoline and in many other applications for which higher alloys were previously thought necessary.

In matching tubing to present-day refining and processing conditions, the cooperation of B&W engineers can prove of inestimable value. This service, based on more than thirty-five years of B&W specialization in pioneering, introducing, and producing tubes for high-temperature—high-pressure service, is available to you.



CROLOY 1¼	CROLOY 2	CROLOY 2¼
Economic grade good creep strength properties. Somewhat more corrosion resistant than the chromium free steels.	Economic grade for resisting both oxidation and corrosion, with excellent high-temperature strength.	*Exceptionally high creep strength* for polymerization and high pressure cracking. Otherwise similar in properties and characteristics to Croloy 2.
CROLOY 3 M	**CROLOY 5**	**CROLOY 5 Si**
Somewhat better creep properties and better resistance to corrosion and oxidation than Croloy 2.	For operating conditions where corrosion resistance is primary requirement—provides good creep strength and oxidation resistance superior to Croloy 2.	For operating conditions where oxidation resistance is a primary requirement. Excellent resistance to scaling.
CROLOY 5 Ti	**CROLOY 7**	**CROLOY 9**
For oxidation resistance. Non-hardening below 1700° F.	Intermediate steel between Croloys 5 and 9 for operating conditions where corrosion resistance is the primary requirement. Somewhat more oxidation resistant than Croloy 5.	For severe operating conditions where high corrosion and oxidation resistance are essential—suitable for hydrogenation processes.

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SEAMLESS. Complete range of carbon, alloy and Stainless steels. Sizes ½ in. to 8⅝ in. O.D.
ELECTRIC-RESISTANCE WELDED Carbon steel grades. Sizes ⅜ in. to 4 in. O.D.

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6405 TA-1312

TABLE I — Marketed Production of Liquefied Petroleum Gas

Year	Total Sales Gallons Per Year	% Incr. Over Previous Year	Distribution—Gallons Per Year: Domestic	% Incr. Over Previous Year	Industrial and Miscellaneous	% Incr. Over Previous Year	Gas Manufacturing	% Incr. Over Previous Year	Chemical Manufacturing	% Incr. Over Previous Year
1922	222,641	....								
1923	276,863	24.4								
1924	376,488	36.0	Sale of liquefied petroleum gas confined primarily to bottled gas business prior to 1928.							
1925	403,674	7.2								
1926	465,085	15.2								
1927	1,091,005	134.6								
1928	4,522,899	314.6	2,600,000	. .	400,000	. .	1,500,000	.		
1929	9,930,964	119.6	5,900,000	126.9	1,500,000	275.0	2,500,000	66.7		
1930	18,017,347	81.4	11,800,000	100.0	2,200,000	46.7	4,000,000	60.0		
1931	28,769,576	59.7	15,294,648	29.6	7,171,686	226.0	6,303,242	57.6		
1932	34,114,767	18.6	16,244,103	6.2	8,167,194	13.9	9,703,470	53.9		
1933	38,931,008	14.1	16,625,588	2.3	13,987,095	71.3	8,318,325	—14.3		
1934	56,427,000	44.9	17,681,000	6.3	32,448,000	132.0	6,298,000	—24.3		
1935	76,855,000	36.2	21,380,000	20.9	47,894,000	47.6	7,581,000	20.4		
1936	106,652,000	38.8	30,014,000	40.4	67,267,000	40.4	9,371,000	23.6		
1937	141,400,000	32.6	40,823,000	36.0	62,610,000	(*)	11,175,000	19.3	26,792,000	
1938	165,201,000	16.8	57,832,000	41.7	62,694,000	0.0	12,386,000	10.8	32,299,000	20.1
1939	223,580,000	35.3	87,530,000	51.4	93,723,000	49.4	15,435,000	24.6	26,892,000	16.7
1940	313,456,000	40.2	134,018,000	53.1	124,482,000	34.5	20,285,000	31.4	34,671,000	29.0
1941	462,852,000	47.7	220,722,000	64.7	172,669,000	38.6	25,255,000	24.5	44,206,000	27.5
1942	585,440,000	26.5	299,559,000	35.7	201,477,000	16.7	31,366,000	24.2	53,038,000	20.0
1943	675,233,000	15.3	339,380,000	13.3	242,978,000	20.6	37,519,000	19.6	55,356,000	4.4
1944	785,000,000	16.2	392,000,000	15.5	287,000,000	18.1	46,000,000	22.6	60,000,000	8.4

*Not comparable due to segration of chemical manufacturing.

Remarks: In the above table "Total Sales" for all years except 1944 were obtained from U. S. Bureau of Mines reports. "Distribution" for the years 1931 to 1943, inclusive, was obtained from the same source. All other volumes are estimated by the writer. The total sales volume includes all liquefied petroleum gases (propane, butane, and propane-butane mixtures) when sold as such. It includes the sale of pentane when sold for any purpose other than motor fuel blending. It does not include butane when blended with heavier petroleum fractions for motor fuel purposes. Inter-company sales transactions such as purchases of liquefied petroleum gases by one company from other companies and then resold as liquefied petroleum gases, have been eliminated in order to avoid duplication of sales figures. The data do not reflect sales of liquefied petroleum gases used directly by the producer at the point of production, for fuel, polymerization, solvent de-waxing, etc. Neither do the figures include sales of hydrocarbons to plants manufacturing synthetic rubber or aviation gasoline or their components.

plant was completed it was announced that it will be doubled in size. This plant will consume about 80,000 gals. per day of LPG. It will be one of the largest hydrocarbon chemical plants in the country.

Another company which has had a war plant on the Gulf Coast at which propane and ethane are used as raw material is to enlarge its plant when the war is over. This plant will utilize 80,000 gals. per day of ethane-propane mixture by pipeline from a recycle unit as well as overhead from a depropanizer tower in another plant.

Propane and normal butane are relatively non-reactive chemically but research has shown they may be processed to produce substances of high chemical reactivity. LPG, for example, may be cracked to yield ethylene, acetylene, propylene and other substances. To these unsaturates all manner of chemical reagents may be added to produce myriads of useful new compounds. For example, ethyl alcohol is produced by chemical synthesis of water and ethylene. Other products from ethylene include ethylene glycol, which is widely used as an anti-freeze, as well as a source for the production of important chemical raw materials, solvents and plastics. The possibility for production of both old and new organic chemicals from light hydrocarbon raw materials are indeed most intriguing and almost without limit as to number.

While the variety of chemicals is great the possible volume is very small when compared with the total supply of petroleum hydrocarbons available for use as raw materials. In 1944 the total volume of all organic chemicals produced in the U. S. was only 78,000 bbls. per day, while the production of crude petroleum was 4,500,000 bbls. per day. The value of organic chemicals is high when compared with LPG, gasoline or crude oil, but the cost of production is correspondingly high because of the large plant investment and the small volumes produced.

During 1944 the outstanding development in the industrial consumption of LPG was the large scale conversion of industrial users from the use of butane to propane. At the outset of the war the major producers of butane began working with their large industrial consumers urging conversion to propane so that the aviation gasoline and synthetic rubber industries would have adequate supplies of butane. Except for those big industrial concerns which had the foresight to install propane tanks even though butane was used, conversion to propane could not then be accomplished because of lack of suitable storage. Where 200-lbs. working pressure storage was available conversions were made in 1943. Where 80 to 100-lbs. working pressure tanks were in place it was necessary to go to the War Production Board for steel allocations in order to make the change-over. Early in the war-period steel was more critical than butane because neither the 100-octane plants nor the synthetic rubber plants were on stream. In the latter half of 1944, however, the steel situation eased and new 200 lb. working pressure tanks could be obtained for essential purposes.

One large industrial plant in the middle west which consumes 20,000 gals. of butane per day up to late October now is entirely converted to propane. In the Chicago area alone one LPG manufacturer was able to reduce its sales of butane about 35,000 gals. per day in recent months by converting its customers to propane. The butane released is being isomerized and used in the production of aviation gasoline or used as raw material for synthetic rubber components.

Wildcat drilling operations throughout the region where the occurrence of oil is anticipated increased rapidly in 1944 as the war threw a tremendous burden on present oil producing fields. These operations in regions remote from natural gas created a large demand for butane-propane mixtures to fuel these drilling rigs. In order to conserve butane-propane mixtures for domestic uses the Petroleum Administration for War recently ruled that LPG may not be used during the winter months in fields where natural gas is available.

The high level of agricultural operations in the irrigated fields of the southwest created an unusually large demand for LPG in the latter part of the summer, when LPG engines driving irrigation pumps were in use. Dehydrating units for alfalfa and similar products, cotton ginning and other farm uses required great quantities of LPG.

There was an acute shortage of product and transportation in January and February, 1944, created by war demands for butane and for pressure cars to carry the light hydrocarbons between manufacturing plants. As a result of this

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Fuel shortages are anticipated again this winter. Once more the Government urges that every possible measure be taken to reduce waste and inefficiency in heating. And one sure, practical step toward the performance of this patriotic duty is through thorough and adequate insulation with Fiberglas Industrial Insulations.

In co-operation with the Government program to save critical fuel.

Yes, any part of any pipe or duct—any boiler, retort, heat exchanger or oven in your plant—that is "too hot to touch" is wasting war-essential fuel and costing you money. Just how much, it might surprise you to learn!

The significant fuel savings effected by Fiberglas Insulations can be seen at a glance on the Fuel Saver Calculator shown above. For example, 2-inch thick Fiberglas PF Pipe Insulation, on 100 feet of 4-inch pipe with a hot-face temperature of 400° F. in an 80° F. surrounding temperature, will save nearly 70 tons of coal a year. And just imagine the costly extra burden such heat losses also put upon air conditioning equipment!

This practical and useful vest-pocket device is yours for the asking. Write for your Calculator today, make a thorough inspection of your plant and add up the amount of fuel proper insulation could save. Then support the National Fuel Efficiency Program—and reduce your plant operating costs—by applying Fiberglas Industrial Insulations wherever there is a spot "too hot to touch".

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2. Blanket Type Pipe Insulation—With mesh wire on outer side to wrap around pipe and secure with wire through special edging. Manufactured in 2-ft. sections for pipes over 3″ O.D. Will withstand temperatures up to 1000° F.

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4. No. 600 PF Block—Same materials as in PF Pipe Covering — in blocks 6″ x 36″ and 12″ x 36″, standard thicknesses.

5. OC-1800 High Temperature Block—A highly efficient and rugged molded block in sizes 3″ x 18″ and 6″ x 36″ and 12″ x 36″—in standard thicknesses. Will withstand surface temperatures up to 1800° F.

6. Insulating Cement—For insulating fittings, valves and all irregular surfaces. Highly efficient . . . withstands temperatures up to 1200° Fahrenheit.

7. OC Mastic Finish—An asphalt emulsion cement for insulated pipe and equipment exposed to outdoor or high moisture conditions.

8. Insulating Wool, Type TW-F—Fabricated in bats, rolls and bulk. Used for drying-ovens, heaters, etc., for filling irregular spaces.

9. PF Insulation—Manufactured in 5 densities from 2½ to 9 lbs. per cu. ft.—standard sizes 24″ x 48″, 1″ to 4″ in thickness, according to density. For insulated panels, sound absorption and various semi-structural applications.

10. PF Roof Deck Insulation—9 lb. density with facing to facilitate mopping. Highly efficient, with incombustible, rotproof and moisture-resistant core, for application under industrial built-up roofings. Sizes 24″ x 48″. Thicknesses from ⅛″ to 2″.

ARMY E NAVY

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INDUSTRIAL INSULATIONS

shortage the PAW appointed a committee from the industry to survey availability of C_3 and C_4 hydrocarbons and to compare these figures with estimated requirements for aviation gasoline, synthetic rubber, and LPG uses. This industry committee has spent an immense amount of time on the problem and has made a number of worthwhile recommendations to PAW.

At the southern section meeting of the Liquefied Petroleum Gas Assn. at New Orleans in September, Paul K. Thompson, Chief of the LPG section of the PAW, presented a paper based on findings of the survey committee which he titled: "Will We Weather the Winter"? Mr. Thompson presented a 9-point program to the industry which included early filling of all classification of customers in order of preference for deliveries during critical periods. Early fall sales curves suggest that many domestic distributors have accepted this advice. The severity of the winter crisis in early 1945 now must depend largely on the severity of the winter.

The conclusion of the German War is expected to cause a substantial immediate curtailment of industrial fuel sales to war plants. The magnitude and duration of this curtailment depends on how many and how soon such plants convert to peacetime operation.

There has been increasing interest by manufacturers of internal combustion engines in the development of an LPG-fueled engine.

Considerable additional study is being made of LPG-fueled units for air conditioning railroad equipment. It is anticipated that propane fired engines, fans and refrigeration units will be developed further for perishable goods cars so that uniform temperatures may be maintained in transit.

Many distributors have been planning for postwar expansion. There is a clearly defined trend to install 200-lb. working pressure storage so they will be prepared to distribute propane, butane or mixtures as market conditions may dictate. In 1944 the War Production Board approved the installation of a considerable number of additional propane storage tanks at previously existing bulk stations. Some of these were delivered and installed in time to alleviate the 1944-45 winter crisis.

Looking to the postwar domestic market the distributor sees that only a little over 10% of the homes in the U. S. without gas service have installed LPG. There are about 15,000,000 homes not connected to gas mains and about 2,000,000 homes served by the LPG industry. For several years after the war it is expected that domestic customers will increase at the rate of at least 500,000 per year.

Indications are that the distributors of natural and manufactured gas will look with a more kindly eye on LPG as a means of building loads in growing communities pending the development of a market dense enough to lay city gas mains. They see in LPG a means of better meeting the competition of electricity.

As a result of the war emergency, distributors in the south where LPG is used for space heating as well as cooking, water heating and refrigeration, are becoming increasingly aware of the burden thrown on the industry by peak winter loads. Before the war, filling during the summer of new domestic consumer tanks tended to level out the demand curve to some extent but now, with new installations a minor factor, the industry sees more clearly the effect of peak demands running 3 to 5 times as great in the December-February period as in the summer.

The peak winter demand of southern domestic customers makes a considerable volume of storage essential. If the storage is to be at the refinery or gasoline plant to take care of winter peaks it will be necessary also to have a large stand-by fleet of tank cars to move the stored product to distributors. The distributor in turn will require excess trucking capacity in the winter which will be idle many months of the year. If storage is provided at distributor bulk plants it will be possible to maintain a tank car fleet of reasonable proportions which can be kept busy through the year but the distributor still will be faced with the maintenance of excess truck capacity. It is becoming clear to southern distributors that the answer lies in enough storage on the consumer's premises to carry them through 45 to 60 days of the winter heating season.

The LPG industry has shown a more co-operative spirit during the past year than ever before. Necessity for group study of the acute problems arising from the war has been at least partly responsible. The LPGA has been more active than ever before. A fine example of co-operative work has been the educational program sponsored by the association. At the time of the Cleveland liquid-natural gas disaster the publicity firm employed by the association was on the ground within a few hours. Interviews were published in the newspapers pointing out that the liquid natural gas which had caused the Cleveland fire and the conditions under which it was stored, were entirely different from butane and propane sold as LPG. This quick work undoubtedly prevented unjustifiable fears on the part of thousands of the industry's customers.

The Transportation Committee of LPGA met with officials of the Petroleum Administration for War, Office of Defense Transportation, and Interstate Commerce Commission early last year during the transportation crisis. The committee was instrumental in the conversion of 600 low pressure cars for the movement of normal butane, butane-butenes and isobutane for war purposes so that the LPG cars commandeered for this service could be returned to their usual service.

Other important LPGA committees which have been active during the year include Safety, Technical and Standards, and Legislation.

Looking forward to 1945 it is clear that the industry will be operating under peak load conditions as long as the global war continues. All elements in the industry will find it essential to keep load building installations at an absolute minimum. When the German war is over the expected cancellation of war contracts should ease the supply and transportation situation on propane but not on butane. Butane is expected to be scarce until Japan is beaten—relatively scarce for a considerable period.

The LPG industry is proud of the record it has made in the service of our country since Pearl Harbor. Manufacturing plants have been built and put in operation to provide vast quantities of raw materials for aviation gasoline and synthetic rubber components. Transportation facilities have been made available for inter-plant movement of war product components. Utilities and munitions manufacturers have been supplied without interruption despite the diversion of tank cars to other services. This record has been achieved only through extraordinary efforts on the part of all elements in the industry.

Industrial propane installation at a large foundry

PISTON LACQUERING—Its Causes and Cures

By H. C. Mougey

The formation of varnish or lacquer deposits on pistons and other engine parts is a problem recognized for many years. It is closely related to the formation of sludge deposits. The whole problem of sludge and varnish may be divided into three classes:

1. **Low temperature.**
2. **Intermediate temperature.**
3. **High temperature.**

The principle cause of the low temperature sludges is water, and varnish is usually not a serious problem at the low temperatures. The principle cause of the intermediate temperature sludges appears to be the fuel and in some cases the oil, and varnish may be serious at the intermediate temperatures. The principle cause of the high temperature sludges is the oil and in this case also the varnish may be serious. Under commercial conditions, all three of these classifications tend to overlap, and in all three classifications maintenance, operating conditions, and engine design are also important factors.

THE formation of lacquer or varnish on pistons is a very broad subject, and there is a divided responsibility for this trouble. The responsibility is shared by the oil and automotive industries and the driving public, and, at the present time, piston lacquering is another one of the things for which at least part of the blame can be placed on the war.

Early Work on Varnish

The importance of the quality of the lubricating oil in respect to varnish formation has long been recognized. There are many standardized oil tests which can be made in the laboratory, but most of these tests[1, 2] are "identification tests" which give information on such factors as methods of refining or the source of the crude, etc., and they are of little value in actually predicting the performance of the oil under service conditions.

Probably the most important property of an oil from the standpoint of formation of varnish is its resistance to oxidation at elevated temperatures.[3]

One of the first important attempts to develop oil specifications, including tests to determine the varnish forming tendencies of oils, was made at the time of the first World War by a committee formed under the auspices of the government. The report of this committee was given in 1918 by C. W. Stratford.[4] Among other things, he said:

"In the light of the most recent study and exhaustive experimentation, the oxidation test appears to be the only dependable and satisfactory method by which the stability of oils can be predicted when they are used in service."

He also reported that, "Poorly refined oils . . . . . usually show high varnish values."

This committee developed tests for "varnish" but they did not incorporate these "varnish" tests into the specifications they proposed because they did not have sufficient correlation between their laboratory oxidation tests and performance in service.

At first there was not much agreement as to the causes of varnish and sludge or as to methods of decreasing them, but gradually the various factors began to be appreciated. It was recognized that there were at least two kinds of sludge, low temperature sludge[5] and high temperature sludge.[6] It was generally appreciated that most low temperature sludges were largely water and oil emulsions, containing, in addition, carbon and other decomposition products from the oil and fuel. It was recognized that high temperature sludges were largely the result of oxidation of the oil,[7] and that there was a great similarity in composition between high temperature sludge and varnish. Table 1 is reproduced from a paper by Gruse and Livingstone.[7] They say:

"A presumption of similarity, if not identity, for the sludge and the varnish from the unstable oil is afforded by the following data, obtained by microanalysis:

TABLE I

	Varnish	Sludge
Carbon, %	74.6	73.1
Hydrogen	6.9	6.7
Oxygen (diff.)	17.8	16.2
Ash	0.68	4.0

"The higher ash content of the sludge might be due to the fact that the sample was obtained by scraping, whilst that of the varnish was recovered by solution in acetone."

Low Temperature Water Sludges

Most of the early work on sludges was on low temperature sludges. In the period following the first World War, a large number of papers were given on crankcase dilution. Clayden,[8] in a paper in 1924, described an extensive series of tests in which he studied the subject of water in the crankcase. He concluded that "the bulk of the water that gets into the oil pan is formed by direct condensation on the internal walls of the cylinders", and that this water so condensed on the oil film on the cylinder walls does not escape with the exhaust gas but remains on the cylinder walls and ultimately finds its way into the crankcase. He showed that the deposition of water by condensation on the cylinder walls stopped when the jacket liquid temperature was 110°F. or higher. He also pointed out,

"It is interesting to observe, in connection with the cessation of water deposition at 110°F., that it is often necessary in refinery practice to dehydrate oil; this can be accomplished by blowing the oil with compressed air, keeping the temperature at 120°F. Blowing at temperatures below 100°F. will not effect separation."

By 1925 many automobile companies had equipped their engines with thermostats and crankcase ventilators, and since that time the problem of water in the crankcase has not been so serious with cars that could be driven at high enough speeds and temperatures, but we have always had the special cases such as door-to-door delivery service, physicians, and others who operate principally on short runs at low speed and temperature.

However, although the use of thermostats and crankcase ventilators, and the operation of engines at higher jacket and oil temperatures went a long way toward curing the low temperature problem, we still had the problem of high temperature sludge and varnish. Even though the oxidation and varnish tests proposed by Stratford[4] in 1918 had never been adopted, the oil industry had continued to work on this problem.

In 1933 the Standard Oil Co. (Ind.)[9] gave a paper on "Causes and Effects of Sludge Formation in Motor Oils" in which they pointed out the relation of sludge and varnish to the composition of the oil, and the importance of refining the oil so as to remove the easily oxidizable sludge-forming materials if it was desired to produce an oil which would give clean engines. In their paper they showed many illustrations of sludge and of varnish-coated pistons and connecting rods from engines operated on oils that were not highly refined. In contrast, they gave records as to engines which operated on well refined oils for very high mileages without any trouble from sludge or varnish.

Although these improvements in refining marked a great step forward, it soon became apparent that in refining the oils to remove the undesirable materials which formed sludge and varnish in use in the engine, the naturally occurring oxidation inhibitors in the oil were also removed to a great extent. As a result, such an oil when subjected to elevated temperatures might oxidize very

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badly, with the formation of acids which would corrode alloy bearings, [10 to 17] and with the formation of oil soluble resins which would be curdled and precipitated by the addition of gasoline or oil,[6, 18] or even by the water[19] resulting from the combustion of the gasoline.

At the 1939 meeting of the S.A.E., comments were made about the severe requirements which were being introduced by the operation of engines at high loads and speeds and temperatures, and the statement was made that at that time (1939) there were "no trade-branded oils on the market able to cope with the 1½ ton truck carrying 10-ton requirements".[20] A similar statement could have been made at that time with equal truth in regard to passenger cars operating at high speeds and high crankcase oil temperatures.

It is well known that one method of decreasing oxidation of the oil is by reducing crankcase oil temperatures. At the Michigan-Life Conference in 1939, Prof. Fenske pointed out that "oxygen attacks an oil at a speed which increases about 2.0 to 2.5 fold for every 18°F. rise in temperature over the range of about 300° to 350°F."[3] However, it is also recognized that one of the best ways of avoiding low temperature troubles is by increasing operation temperatures, and that oils which will stand high temperatures without oxidation or decomposition are very desirable. Consequently, the oil industry has been working very vigorously on the development of oils able to withstand high temperatures.

This work has resulted in the development and commercialization of heavy-duty oils.[6, 10, 21-31] Although these oils were originally developed for high temperature conditions, it was soon found that they were very effective in decreasing low temperature trouble[5] as well. By 1941 the oil industry was in large production on these oils. However, when the Japs bombed Pearl Harbor and the U. S. was plunged into war, the demands of the Army and Navy for heavy-duty oils became so great that these heavy-duty oils had to be withdrawn from use in passenger cars and reserved for the use of the military forces[32] and for operators of trucks and buses.

Commercially, the problem of piston varnish reached its peak about 1939, just before the general introduction of heavy-duty oils. At the January 1939 meeting of the S.A.E. in Detroit, F. F. Kishline[33] gave a report on the views and experiences of a number of members and companies represented in the S.A.E., and a year later at the 1940 meeting, he gave a second paper.[34]

In the first paper (1939), Kishline reported considerable trouble, chiefly at high oil temperatures, although one company did report that their "interest in this condition concerned only the filling of the slots in the oil-control rings with this varnish gum", and that they produced "this varnish at comparatively low speeds, light load, and low sump oil temperatures (160 to 190°F.)".

In the second paper (1940), Kishline reported: "In general, the answers to the various questions indicated: (1) That varnish or lacquer formation in engines is not, or is no longer, a serious problem. Several contributors reported that formation had been eliminated or reduced by changing to another grade of oil or fuel, or installing oil coolers."

Effect of Character of the Fuel

The importance of the fuel in the formation of sludge and varnish has been recognized for a long time.[26, 35, 36] Provisions are made in the CRC engine test procedures L-1 to L-5[37] to take care of the factor of quality of the fuel. Marley and Gruse[38] and Gruse and Livingstone[7, 39] have commented at length on the effects of fuel, especially its gum content and its volatility, on piston varnish. They divide the problem into three classifications.[39]

"1. Cold weather emulsions of water and oil, the stabilizing agents being largely combustion chamber products.

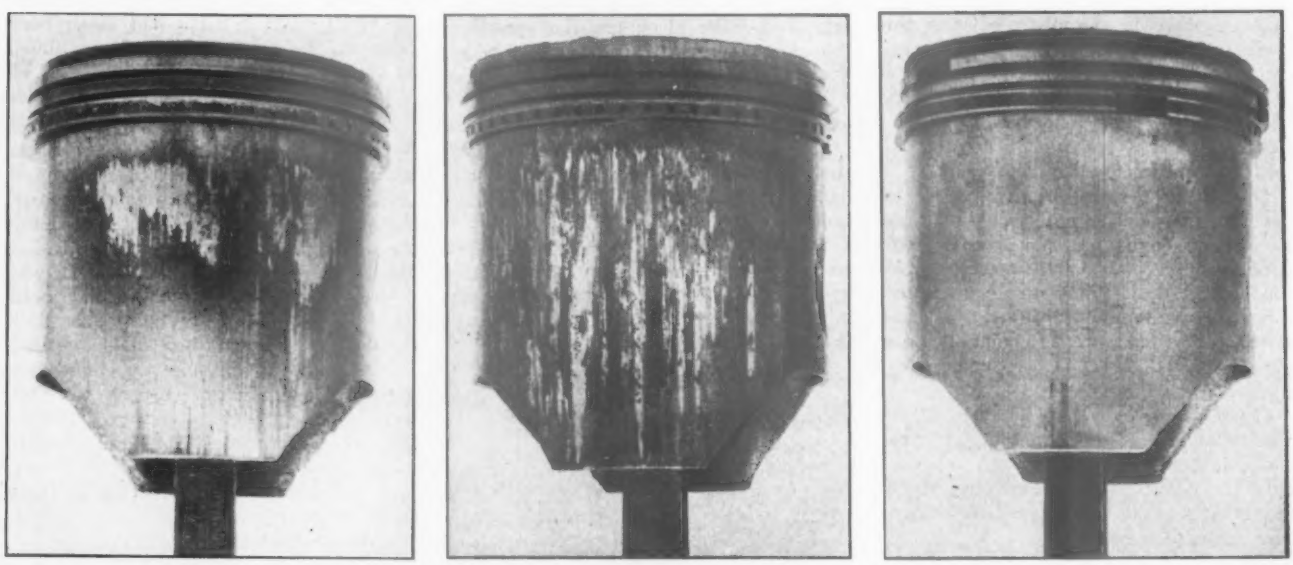
"2. Intermediate temperature sludges, apparently characteristic of varied automotive service. Water influences the course of the oxidation which forms the deposit, but makes up no great part of the sludge itself.

"3. High-temperature carbonaceous muds, characteristic of very heavy duty."

In a recent paper, Lane of the Socony-Vacuum Oil Co. discusses the various factors, including operating conditions, water, gasoline, and oil; and although the general public are inclined to blame the oil and high oil temperatures for most of their trouble, Lane points out that these are not the only causes. He says:[40]

"Contrary to general supposition, the bulk temperature of the oil does not need to be excessively high to have varnish form. Certain very different makes of

Fig. 1—Results of Tests for Varnish Deposit



Test No. 1 **Test No. 2** **Test No. 3**

In both tests 1 and 2, the procedure outlined for Schedule B (Table 2) was used. In test 3, CRC Test Procedure L-4 was used.

Jacket temperature was 94° F. for the first two tests, increased to 200° for the third; oil temperature was 154° F. for the first two tests, increased to 265° for the third. Fuel in each test was gasoline "A".

Oil Used: Test 1—straight mineral X, SAE 20 (this oil is the base oil used in making heavy-duty oil Y). Test 2—heavy-duty oil Y, SAE 20, made by addition of compound to oil X. Test 3—heavy-duty oil Z (same base oil as heavy-duty oil Y but SAE 10 viscosity).

Hours of Test: Test 1—pistons stuck-up in 25 hrs. Test 2—pistons stuck-up in 25 hrs. Test 3—O.K. at 36 hrs.

AT WAR.... on Both Fronts

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engines, in which the oil temperatures run from 175°F. to 190°F., have considerably greater tendency to form varnish than other engines which run in the same range or even higher (215°F.)."

Lane makes a number of suggestions to remedy these troubles. He includes ventilation, good gasoline, certain operating and maintenance practices, and detergent type oils, but he does not claim that the detergent type oils will cure the troubles for which the gasoline or other factors are responsible.

Moderate Temperature Tests

Although the various factors involved in low and moderate temperature sludge and varnish troubles are known in a qualitative sort of way, and there are standardized Diesel[37] engine tests (L-1, L-3, and L-5) which cover the crankcase oil temperature range of from 140° to 230°F. inclusive, there are no generally recognized tests to measure the tendency of an oil or of a fuel to form sludge or piston varnish in gasoline engines at low or moderate oil temperatures.

At the December meeting of the S.A.E. at San Francisco on Dec. 12, 1944, J. T. Ronan of the Shell Oil Co. gave a paper[41] in which he showed the results of tests on straight mineral oil and oils with heavy duty type compounding in a combined high temperature and low temperature schedule. The straight mineral oil gave bad varnish and sludge and oil-control ring plugging, but the compounded oils gave excellent results. However, although this test may be of very real commercial importance, it is a combination of both high and low temperatures, and the poor performance of the straight mineral oil may have been due to oxidation at the high temperatures employed.

In 1943, Harry Moir of the Pure Oil Co. reported on a test[42] using low temperatures. The suggested procedure was intended to throw light on the results that might be expected from "A" card drivers under very severe conditions. The jacket temperatures ranged from 50 to 75°F. and the oil from 40 to 156°F. A well refined high VI straight mineral oil was used. Although large amounts of "water-sludge" were obtained, there was not much trouble from varnish or oil-control ring plugging. This suggests that the test schedule was too low in temperature to be typical of service, except perhaps under very severe conditions.

In an attempt to develop an intermediate temperature test schedule which would be affected by a moderate amount of water condensation in the cylinders, but which would not produce any water in the crankcase, The Texas Co. developed the test procedure in Table 2. For convenience this is called Schedule B.

The analyses of some gasolines used in tests on this schedule are shown in Table 3.

On this schedule, with the jacket at 94° and the oil at 154°F., using gasoline A shown in Table 3 and a straight mineral oil X, the base oil used in making a certain commercial heavy duty oil, bad varnish was obtained (Test No. 1, Fig. 1). The pistons "stuck up" in 25 hours, making it necessary to stop the test. When the same gasoline A and the heavy duty oil itself were used, the results were no better, except there was less tendency to plug the oil-control rings (Test No. 2, Fig. 1).

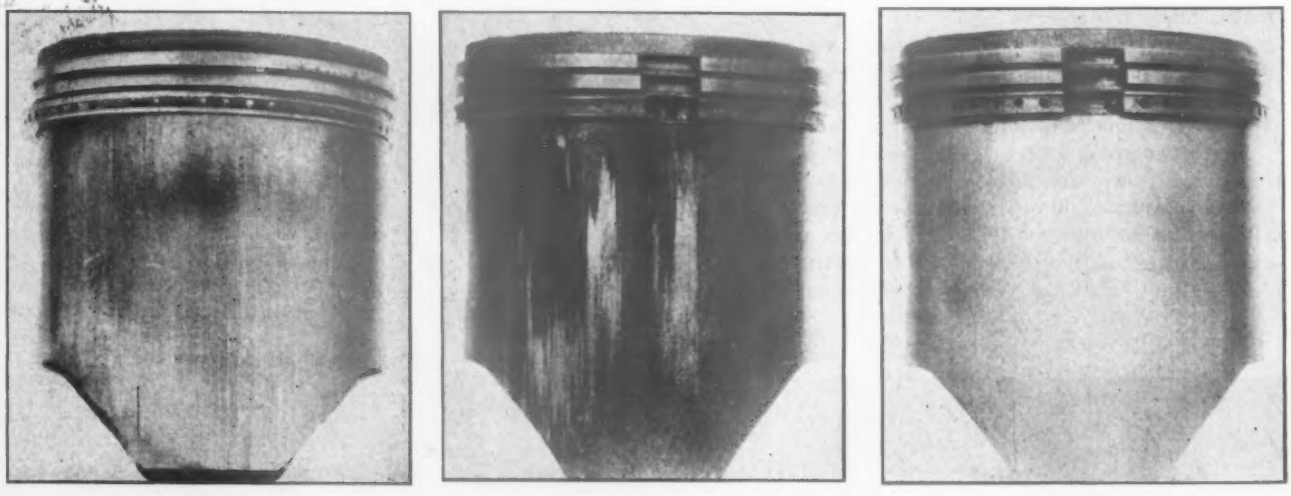
However, using this same gasoline A and heavy duty oil Z, an excellent 36 hour test was obtained on the L-4 schedule with the jacket at 200° and the oil at 265°F. (Test No. 3, Fig. 1); and a slightly better L-4 test was obtained using gasoline B (Table 3) and heavy-duty oil Z.

Using gasoline B (Table 3) and the same straight mineral oil X on the low

TABLE 2—Conditions for Intermediate Temperature Test (Schedule B) for Sludge and Varnish Deposit

Oil	Either High VI highly refined straight mineral or Heavy Duty Oil, as desired.
Fuel	3 cc ethyl 75 octane minimum.
Oil	154 plus or minus 5.
Jacket Out	94 plus or minus 5.
Jacket In	84 plus or minus 5.
Ventilation	1 cu. ft./min.
Load	45 BHP.
Speed	2500 RPM—(47.5 MPH).
Air-Fuel Ratio	14.5 to 1 plus or minus 0.5.
Oil Samples	4 oz. at 2, 4, 6, 8, 10, 20 & 30 hrs. 1 qt. at 40 hrs.
Oil Additions	Make up to 4½ qts. at 20 and 30 hours.
Operating Schedule	9 hours per day, shut down over night, or 24 hours per day, as desired.
Valve Clearance, Hot	Intake .008", and Exhaust .013".
Bearings	Copper Lead.
Crankcase Cooling	Water on sides and pan.
Intake Manifold Heat Control	Heat "off".

Fig. 2—Results of Tests for Varnish Deposit



Test No. 4 **Test No. 5** **Test No. 6**

These tests were all performed in accordance with Schedule B, jacket temperature in each case being kept at 94° F. and oil temperature at 154° F. Fuel for test 4 was gasoline "B", for test 5 gasoline "A", and for test 6 gasoline "C". Oil used in each test was straight mineral X, and the length of each test was 40 hrs.

Test 4 was run by General Motors Corp., and tests 5 and 6 by The Texas Co.

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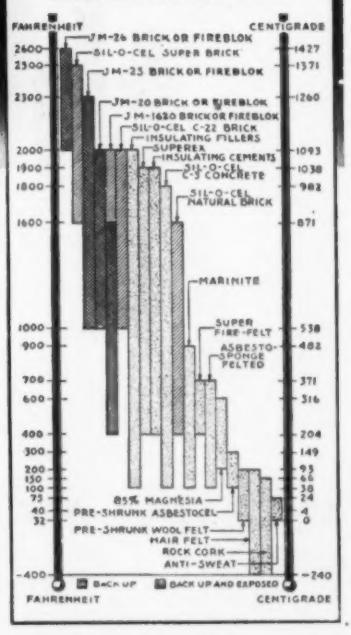

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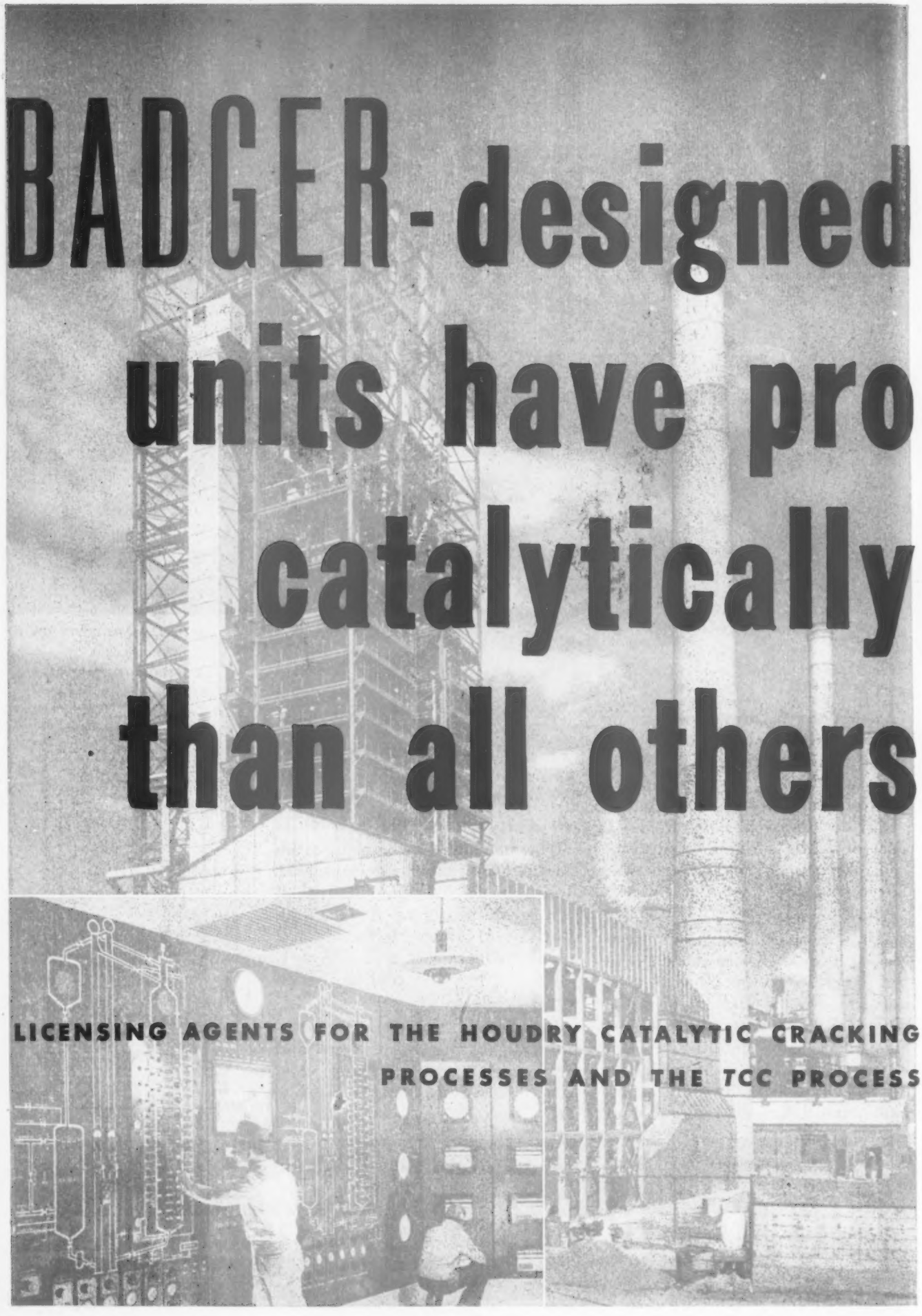
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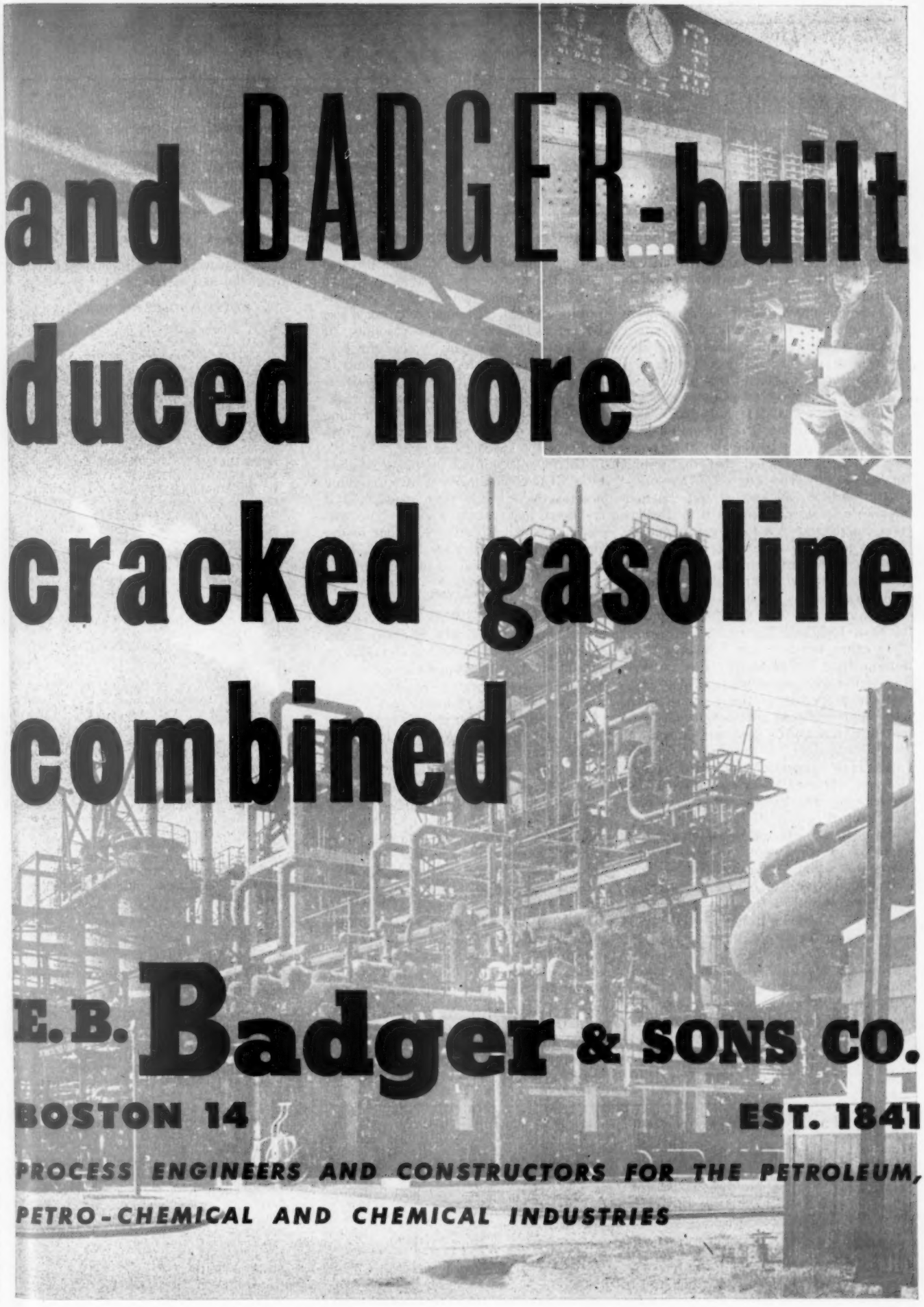
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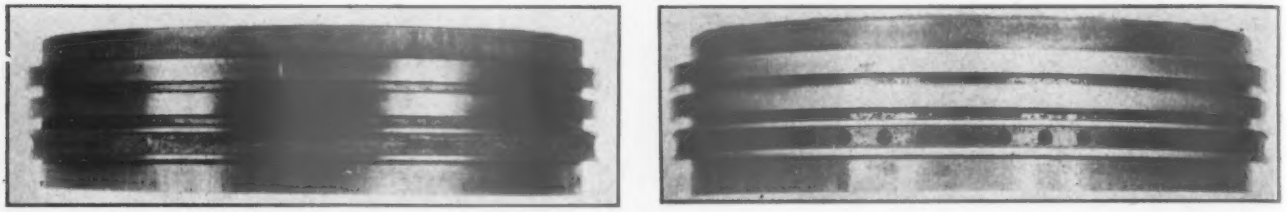
Fig. 3—Oil-Control Rings from Varnish Tests



Oil-control rings from Test No. 5, badly plugged in 40 hours **Oil-control rings from Test No. 6, very clean in 40 hours**

temperature schedule, practically no varnish or sludge were obtained (Test No. 4, Fig. 2).

Although the tests just described were made in one laboratory and used certain specific gasolines and oils, similar results have been obtained in several other laboratories using the same and other gasolines and oils.[43] Two of these tests are shown in Figs. 2 and 3. Gasoline C was prepared by adding 3 cc tetraethyl lead to a gasoline made by the alkylation process. It will be noted that the results in this test by The Texas Co. are practically perfect. In another test the fuel was a duplicate of gasoline B in distillation range and A.S.T.M. gum content. It was made by redistilling gasoline A. However, the results obtained with this fuel on the low temperature schedule were practically a duplicate of those previously obtained with gasoline A (similar to Tests 1, 2, and 5).

In other words, using Schedule B at intermediate temperatures, the properties of the oil were of minor importance, but the properties of the gasoline were very important. At intermediate oil temperature, the results were either bad or good, depending on the gasoline used; but at high temperature, provided heavy-duty oil was used, good results were obtained even with gasolines that gave bad results on Schedule B.

From these tests and others previously reported in other papers,[5, 6, 41] it appears that although heavy-duty oils are desirable for both high and low operating temperatures, there still may be some cases where piston varnish develops due to the character of the gasoline, and in such cases the oil may be incorrectly blamed for the trouble due to the gasoline.

In the tests just reported, a gasoline caused bad piston varnish at moderate temperatures, and the same gasoline and a good heavy-duty oil gave good results at high oil temperatures. However, there are considerable data to indicate that when the heavy-duty oil does not have a high enough "factor of safety", the results at high oil temperature may also be greatly affected by the gasoline. If a heavy-duty oil which is near the border-line in respect to the requirements of U. S. Army Specifications 2-104B is tested, the kind of gasoline used in making the L-4 engine test may determine whether or not the oil meets the requirements of the specification.

This whole subject is being studied by a CLR Committee.[44] Considerable progress has already been made, and it is hoped that within a short time this committee will have the solutions to the various problems that are involved, both at moderate and high oil temperatures.

Conclusion

In conclusion, the work which has already been done on this whole problem of sludge and varnish indicates that it may be divided into three classes:

1. Low temperature.
2. Intermediate temperature.
3. High temperature.

The principal cause of the low temperature sludges is water, and varnish is usually not a serious problem at the low temperature. The principal cause of the intermediate temperature sludges appears to be the fuel and in some cases the oil, and varnish may be serious at the intermediate temperatures. The principal cause of the high temperature sludges is the oil and in this case also the varnish may be serious.

Under commercial conditions, all three of these classifications tend to overlap, and in all three classifications maintenance, operating conditions, and engine design are also important factors. Although we do not have generally recognized tests to evaluate all these factors, active work on these problems is being conducted by the oil and automotive industries, and it is hoped that we will have the answers to the remaining problems in the near future.

TABLE 3—Analyses of Gasolines Used in Schedule B Tests

Gasoline	A	B	C
10%	145°F.	146°F.	163°F.
50%	257	198	222
90%	365	289	267
E.P.	419	358	350
ASTM gum (mg)	6.8	2.0	...
cc TEL/gal.	3.0	2.9	3.0
Aromatics	15%	8.6%	...
Olefins	25%	29.4%	...
Sulphur	0.07%	0.07%	...
Copper Dish Gum (mg)	25	23	1.0

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    In view of the results obtained in these different laboratories using various gasolines, care should be used in drawing conclusions as to the effects of the differences in composition of gasolines A, B, and C described in this paper.
44. This is a sub-committee of B. E. Sibley's C.L.R. Oxidation Tests Group.

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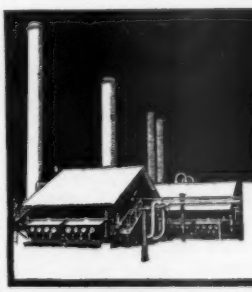

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Use of Cracked Gas Oils As Burner Fuels Being Tested

SINCE the ever-increasing military demand for aviation gasoline and Diesel fuels has become evident, there has been concern over the supplies of conventional gas oils for pot-type wall-vaporizing burners. The obvious solution appeared to be the use of cracked-thermal or catalytic-gas oils to augment fuel supplies for this service. However, in the early part of 1944 rumors that cracked material was unsatisfactory began to be heard.

In order to settle the question for their membership, both for war- and peace-time, Western Petroleum Refiners Assn. began an extensive research program to compare the burning characteristics of available fuels. While not by any means complete, the test program is well-defined and under way. A progress report has been issued recently for limited circulation.

The rumor prompting the investigation was to the effect that cracked materials in the fuel were unsatisfactory because of increased smoking, instability (gum), and a tendency toward formation of hard carbon deposits in the bottom of the pot as well as excessive soft side-carbon which plugs the air-intake ports. These characteristics were thought to be due to the presence of olefins and aromatics ordinarily found in both catalytically and thermally cracked gas oils.

Deposition of soot around the air inlets obviously will seriously interfere with proper combustion of the fuel. Carbon deposits on the bottom of the pot usually are of the hard type, thus exerting an insulating effect which prevents proper temperature control and interferes with satisfactory distribution and vaporization of the fuel.

Solutions Also Sought

The original purpose of the investigation has since been expanded to include not only the answer to the question "are cracked gas oils satisfactory or unsatisfactory for pot-type burners" but also "what can be done about it."

It appears now that some sort of compromise may be necessary on the part of both burner manufacturers and the refiner supplying the fuel, the former because certain modifications in design may help eliminate the problem, if it really exists; and the latter because design modification alone probably will not be the cure-all. It is estimated that there are more than 2,000,000 such burners now in use, all of which cannot be classed as obsolete.

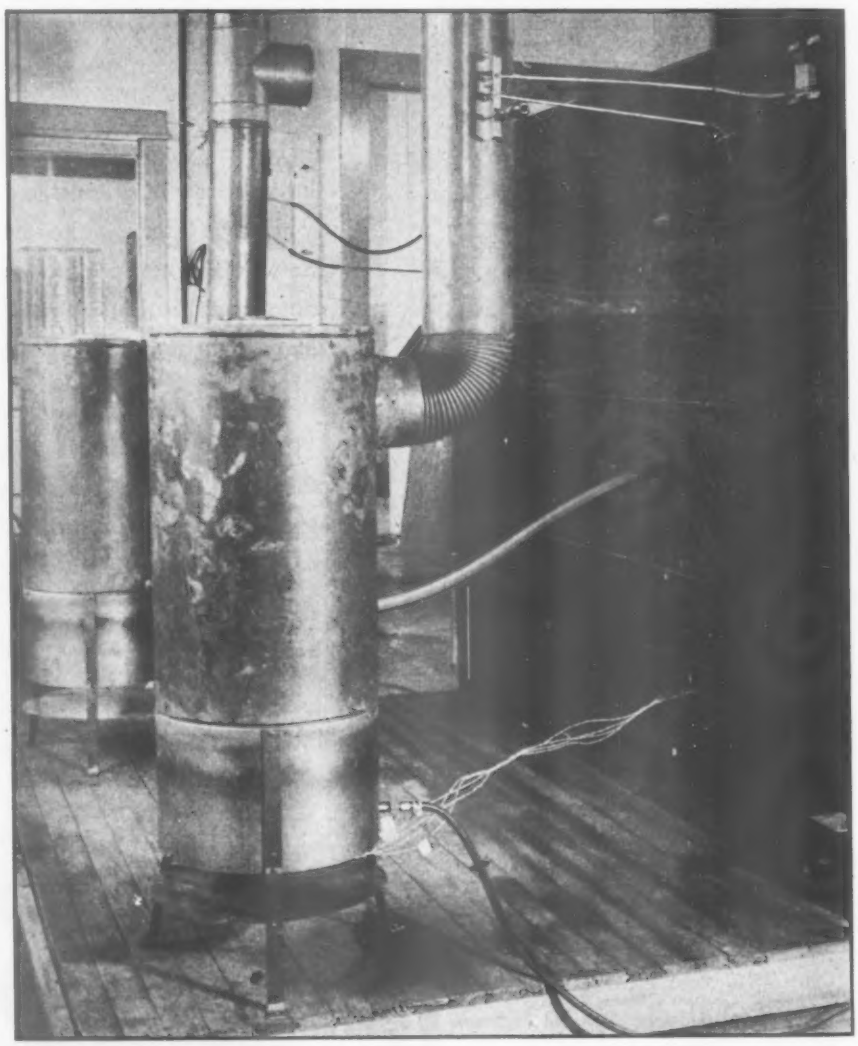
The W.P.R.A. tests thus far have been conducted according to the requirements of Commercial Standards Test 101-43 for determining smoke, and a 20-hour burning test using 80 lbs. of fuel with suitable measuring equipment to determine pot temperature, stack and burner draft, fuel rate, room and stack temperature, and flue gas analysis. Fuels used also are analyzed, with distillation data, aniline number, amount of unsaturates, sulfur, corrosion, viscosity and color being determined in addition to the usual inspection tests for commercial fuel oils.

Test Procedure Described

Tests are being conducted with "Coleman Model M-511" heaters with outside ornamental paneling removed, equipped with 10-in. "Breese-type" vaporizing burners, installed to permit access to the burner for periodical checks and cleanouts after completion of each test. Fuel input rate is measured by an automatic feed control and adjusted for high-fire operation after initial warm-up time.

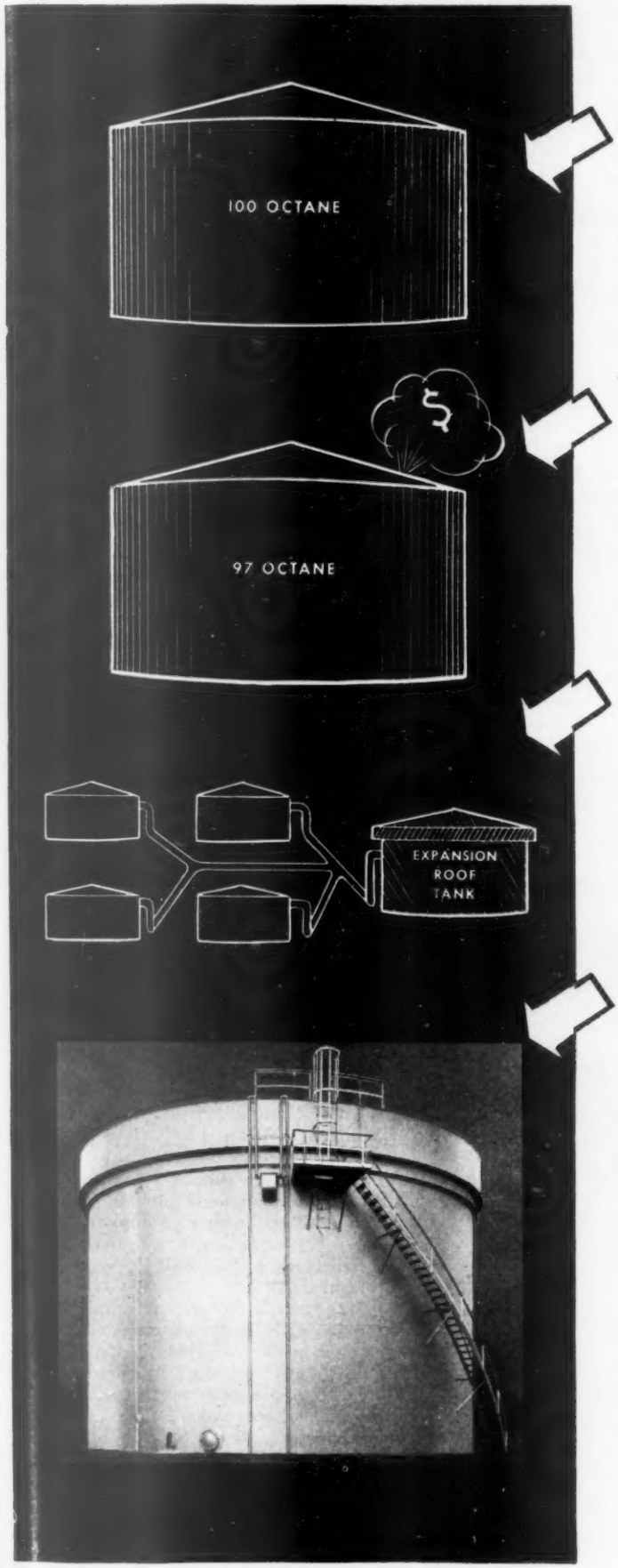
A fuel input-rate of 3.60 lbs. per hour was agreed upon as representing a normal high-fire burning rate for the heaters used. In obtaining the data, the test was begun on low-fire operation rate being increased gradually until high-fire operation was obtained. For the first tests, 20 minute burning tests are used to select the "best" fuels for further examination.

In the 20-hour burning test, several modifications over the set-up for initial tests were used. The position of one thermocouple was changed from midway between thermocouples at ½ in. from inlet and center to midway between thermocouples at center and ½ in. from far side of the pot. Burner and pot were dismantled immediately following the test for examination of deposits and record-photographs. The draft was adjusted to represent 20% ± 2½% of Institute of Cooking and Heating Appliance Man-



Test set-up for W.P.R.A.'s burning oil quality investigations. Illustration shows the pot type burner with instrument connections on the flue for measuring percent smoke, draft and stack temperatures. The large pipe entering the heater measures burner draft, the smaller pipe is the fuel line, while the wires are thermocouple connections on the pot bottom

Facts about evaporation losses



A 10,000 barrel cone roof storage tank filled with 100 octane gasoline.

The same tank one year later. Change in temperature has caused breathing. During the daily expansion period, saturated vapors were expelled through relief valve—entirely lost. On this size tank it means 4% evaporation loss, or 16,800 gallons, as well as a three point drop in octane rating. Now the gasoline is only 97 octane.

This is a Graver Expansion Roof Tank manifolded to several cone roof tanks. As vapors expand they are forced into the Expansion Roof Tank. The roof rises, provides ample vapor space—holds all vapors—expels none. Result, no loss of gallonage—no lowering of octane rating.

A Graver Expansion Roof Tank, one of the many installed at refineries and pipeline terminals of the country's leading oil companies. Used either singly or manifolded to several cone roof tanks, this equipment is saving thousands of gallons of gasoline annually and maintaining its quality at the same time. Translated into dollars, this represents an enormous saving—one which can liquidate the original investment in a comparatively short time. Graver will be glad to show you how you can enjoy these same savings.

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In tests so far made, samples were selected from the different types of crude found in the Midcontinent, and include both catalytic and thermal processing. Twelve have so far been examined and include: Straight-run, Kansas-Oklahoma; No. 1 heating distillate, Kansas-Oklahoma; No. 2 heating distillate, Kansas-Oklahoma; No. 1 heating distillate 100% cracked, Texas; "Fluid" catalytic cracked, Midcontinent; "Houdry" catalytic cracked, Kansas-Oklahoma; "Thermofor" catalytic cracked, Midcontinent; straight-run distillate, Kansas-Oklahoma; prime white straight-run distillate, Kansas; straight-run No. 2 distillate, West Texas; thermal cracked No. 2 distillate, West Texas, and "Fluid" catalytic cracked, Oklahoma-Texas sweet crude. Conclusions from these initial tests are regarded as tentative, and therefore have not been released for publication.

At the conclusion of the 20-hour burning tests, the deposits were carefully removed from the burner, that from the pot bottom being segregated from carbon appearing on the sides. Deposits were weighed before and after drying, and a determination of characteristics made.

Blends to be Investigated

No small volume of petroleum products are involved in the pot-type burner market. These 2,000,000 units will consume a conservative estimate of 42,000,000 bbls.* annually. In the past, straight-run fuels and blends of straight-run with thermally-cracked distillates have been used successfully. However, with the wartime installation of large capacities in catalytic cracking, authorities believe that the future will see less and less of straight-run distillates on the market, while there will be relatively large quantities of cracked material available, because the emphasis will be on the straight-run material as a cracking stock instead of for sale as a fuel.

Future investigation, therefore, will be in the nature of examining blends of straight-run, thermally- and catalytically-cracked distillates to develop a fuel even better than has been available in the past. The use of additives is reportedly under consideration by some refiners and undoubtedly research towards this end may be expected on the part of refiners and chemicals manufacturers alike.

When its research program is concluded, W.P.R.A. hopes to develop specific information for its membership which will permit the manufacture of the best possible type of fuel for these heaters. At the same time, it can work with stove manufacturers in the development of equipment prepared to get the utmost out of fuels which will be available under the probable methods of post-war refining in vogue.

The information (which may ultimately be revamped according to the individual plant's set-up) will show the types of gas oil to be used in making the various grades of burning oils. Investigations under way may show that not only the type of crude but the type and method of refinery operation will have strong bearing on quality of burning oil which can be produced.

A.S.T.M. Also Investigating

Working along the same lines as W.P.R.A., but with a more immediate objective in view, the American Society for Testing Materials also is investigating fuel oils. The A.S.T.M. tests, however, are intended to develop the best possible 1945 fuel for these heaters in terms of the materials available under current war-time refinery operations rather than chart the peace-time course as well.

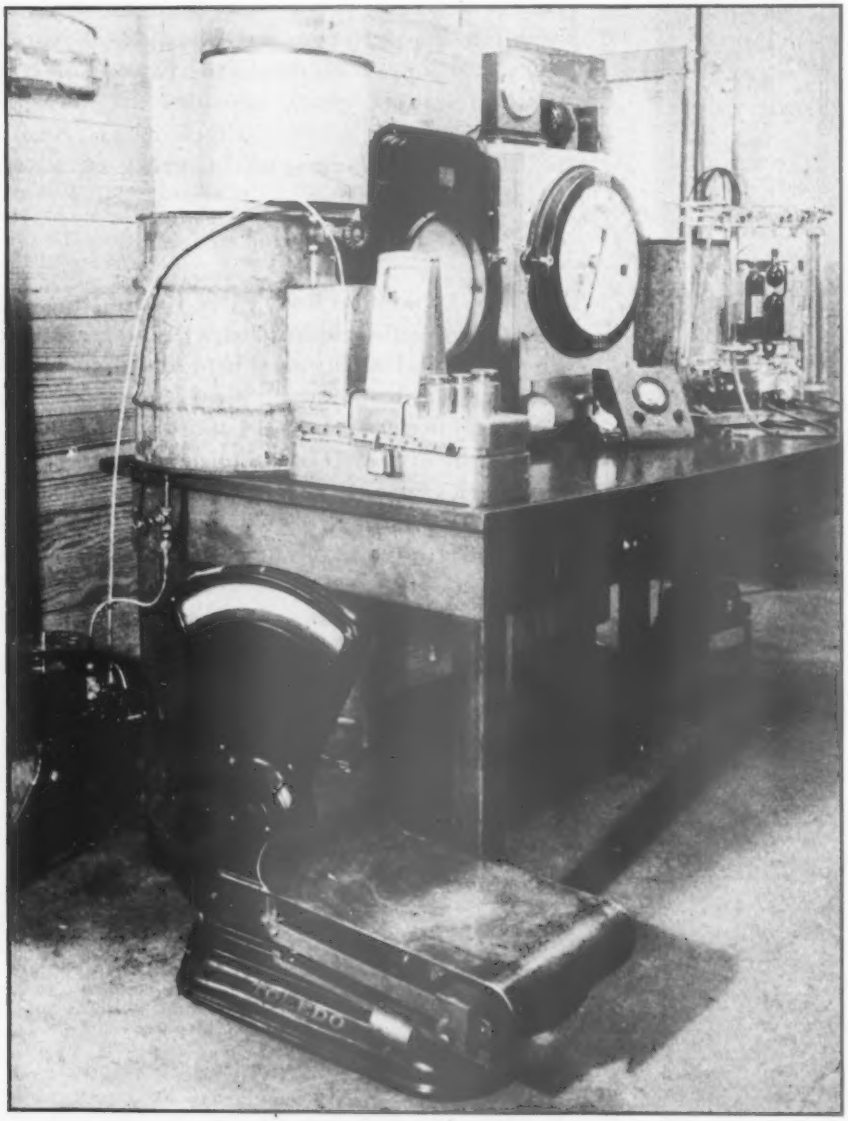
The technical committee for PAW District 2 also has had the subject under consideration, having reached these tentative conclusions in a report made to the district's refining committee in September, 1944:

"(1) There is no reason to believe that quality of furnace oils in District No. 2 will become a problem or more of a problem because of catalytic cracking. For critical and sensitive burner installations a No. 1 fuel or kerosine is available.

"(2) Satisfactory No. 2 Furnace Oils can be made from catalytic stocks, and as more work is carried on, individually and perhaps co-operatively, it will probably be found that substantial amounts can be incorporated in time in No. 1 fuel oils.

"(3) We do not consider it necessary nor recommend that District No. 2 Refining Committee institute any active work along this line, because the situation does not warrant it."

*Estimated 12 hour operation over six months, firing at 3 lbs. per hour, fuel weighing 7.4 lbs. per gal.



Instrument panel for burner fuel tests. At extreme left is the fuel metering device and just above it is a draft gage. The instruments visible on the table include a temperature recorder and Orsat gas analyzer

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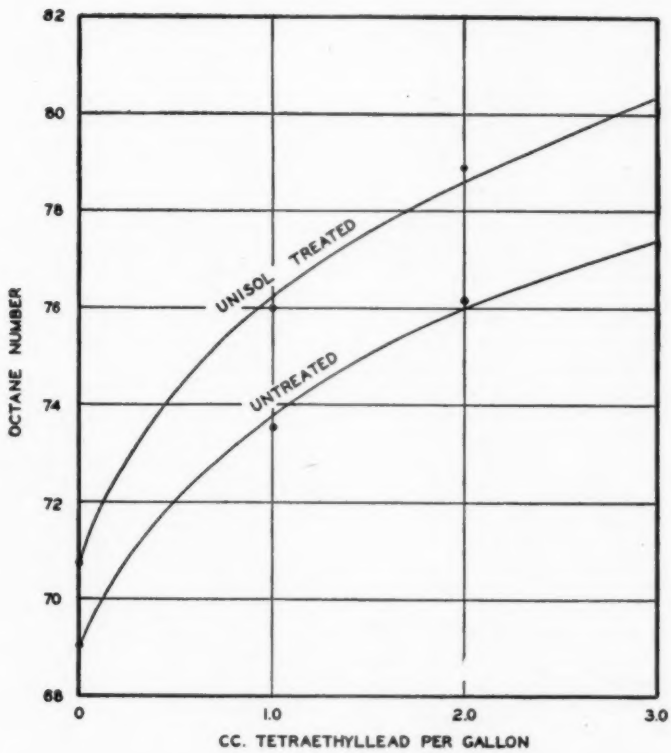
is the chemical symbol for mercaptans — foul-smelling sulfur compounds—which deprive gasoline of the full value of tetraethyl lead

Removing it — not converting it to a less odorous sulfur compound — can be profitably done by the Unisol mercaptan extraction process

Here is a typical result from a commercial Unisol unit designed and licensed by U. O. P.



GASOLINE POWERS THE ATTACK — DON'T WASTE A DROP

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Keeping Up With the News

*By N.P.N. Special Writer**

This series is intended to present a brief, technical-economic account of several of the many new developments in scientific and industrial circles which may relate to the future of the petroleum industry.

Events during recent weeks have focused attention on such divergent subjects as railway Diesels, the Synthine process, a new chemical company, synthetic organic chemicals, automobile developments, carbon disulfide, and synthetic ammonia. These topics are discussed in the current article.

The author of this series is a chemical engineer in the research subsidiary of one of the larger oil companies. His duties include a continuous survey of the current technical and economic journals in the many fields now related to the petroleum industry.

Railway Diesels

Both the petroleum and the railroad industries have for some time been cognizant of the fact that "the coal-burning steam locomotive which has powered America's railroads for more than a century is losing ground to a young upstart, the oil-burning Diesel engine." In fact, "for every main-line steam engine they (locomotive makers) have agreed to make, they have signed up to produce two Diesels. In the field of switching engines, where Diesels have long played a major role, the orders are 205 to none."[1]

"The long use of the old iron horse has still left its total number far ahead of the relative newcomer," however; as of Nov. 30, 1944, the railroads owned 39,740 steam locomotives and only 2389 Diesels. In addition, coal-carrying and coal-mine owning railroads, worried by the trend, are planning "a two-pronged attack" to meet the Diesel challenge: (1) joint research with the coal industry to develop a better coal fuel—perhaps a powdered mixture of anthracite and bituminous, and (2) research into the development of new types of coal-burning locomotives.

The Pennsylvania Railroad, for example, is testing an engine, designed and constructed by the Baldwin Locomotive Works and the Westinghouse Electric & Manufacturing Co., which uses two turbines for motive power, one for forward motion and one for reverse. Other railroads are working on high-pressure steam turbine engines, while still other combines are conducting research on engines powered by gas turbines.

Coal interests have reason to be alarmed. Main-line Diesel engines can make longer runs without refueling—600 to 800 miles on one load of oil, while even the best steam passenger trains must refuel once on the New York-to-Chicago run; steam freight trains usually coal five times on the same run. Interest in main-line Diesels has for some time been centered in the West and certain sections of the South, especially in regions into which coal must be shipped. Arid sections of the West pose a problem of water supply for steam locomotives which is absent in the Diesels. For switching work, Diesels are both economical and convenient, being far more flexible than coal burners.

The Diesel engine, in any field, has the double advantage of: (1) an efficient engine cycle and (2) a low-cost fuel (at least at present). The supply picture for quality Diesel fuels is somewhat clouded by the fact that catalytic cracking plants prefer much the same distillate stocks for gasoline manufacture as are required for premium Diesel fields, but technical developments—perhaps including the addition of pro-cetane additives to lower-grade fuels—should enable the petroleum industry to profit by the trend toward increased use of Diesel fuels in Diesel-powered trains, ships, buses, trucks, and stationary engines.

Synthine Process

Domestic commercialization of the Synthine (Fischer-Tropsch) process, using natural gas as a raw material, has appeared imminent for some time. Reference was made last month[2] to certain reports of such developments and to pertinent figures on the process revealed by R. P. Russell of the Standard Oil Development Co. Another rumored project has been publicized since that date—said to involve the expenditure of "several million dollars" for a plant to be erected in the Carthage, Tex., gas field.

More important than any such rumors, however, is a recent announcement of the M. W. Kellogg Co. (recently purchased by Pullman, Inc., incidentally). According to this announcement,[3] a "new engineering development" makes possible "the production of 75-octane gasoline from natural gas for about five cents per gallon, bringing gasoline synthesis definitely within the range of successful commercial operation." This cost is said to be based on natural gas at 5 cents per thousand cubic feet and a plant depreciation of 10% per year. It is further said that "the gasoline produced can be easily leaded to 80-octane with 1 cc. of tetraethyl lead."

According to the report, "a yield of 80% (presumably based on the primary product) is obtained as a major product compared with the prewar European yields by the then-existing methods of 30-40% of gasoline of approximately 25 octane number."

All of these figures check well with R. P. Russell's 1943 estimates for a Synthine plant of "possible future design," although they do not agree at all with estimates made public at the same time by the Koppers United Co.

The Kellogg Co. is said to be prepared now to build plants using its method, and it may not be long after the war before all cost estimates will meet the acid test of actual operations.

New Chemical Company

"Considerable interest was aroused in chemical circles by the announcement that the American Cyanamid Co., jointly with The Texas Co., has formed a subsidiary to manufacture chemicals from petroleum. This follows similar arrangements among other chemical producers and large oil companies.

"The developments are an answer to the claims sometimes heard that the oil industry is going to take over the chemical business or put chemical producers out of business. The advances in petroleum chemistry have been one of the outstanding chapters in recent American scientific history, and petroleum is expected to become an increasingly important raw material for a wide range of organic chemistry.

"Major research has been done in this field, both by oil and chemical companies, but the oil companies, gen-

[1] Kelly, J. D., *Wall Street Journal* CXXV, No. 1, 1 (1945), "Railroad Research."

[2] *NATIONAL PETROLEUM NEWS*, *Technical Section*, 37, No. 1, R-48 (1945), "Keeping Up With the News—Synthine Production."

[3] Anon., *Wall Street Journal* CXXV, No. 2, 5 (1945), "M. W. Kellogg Makes Motor Fuel from Natural Gas at 5 Cents a Gallon."

More inside information on POWELL VALVES

This small size 200-pound "White Star" Bronze Gate Valve looks very much like the same type of valve in other makes. But back of it—back of every Powell Valve—is nearly a century of specializing in the manufacture of Dependable valves for Industry.

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The complete Powell Line includes all types of valves (Globes, Angles, Gates, Checks, Y's, etc.) not only in bronze, iron and steel but also in a wide variety of pure metals and special alloys to meet every requirement for corrosion resistance (Catalogs on request).

And if you have any unusual flow control problems, Powell Engineers will be glad to make a careful study of your requirements and design special valves to meet the conditions.

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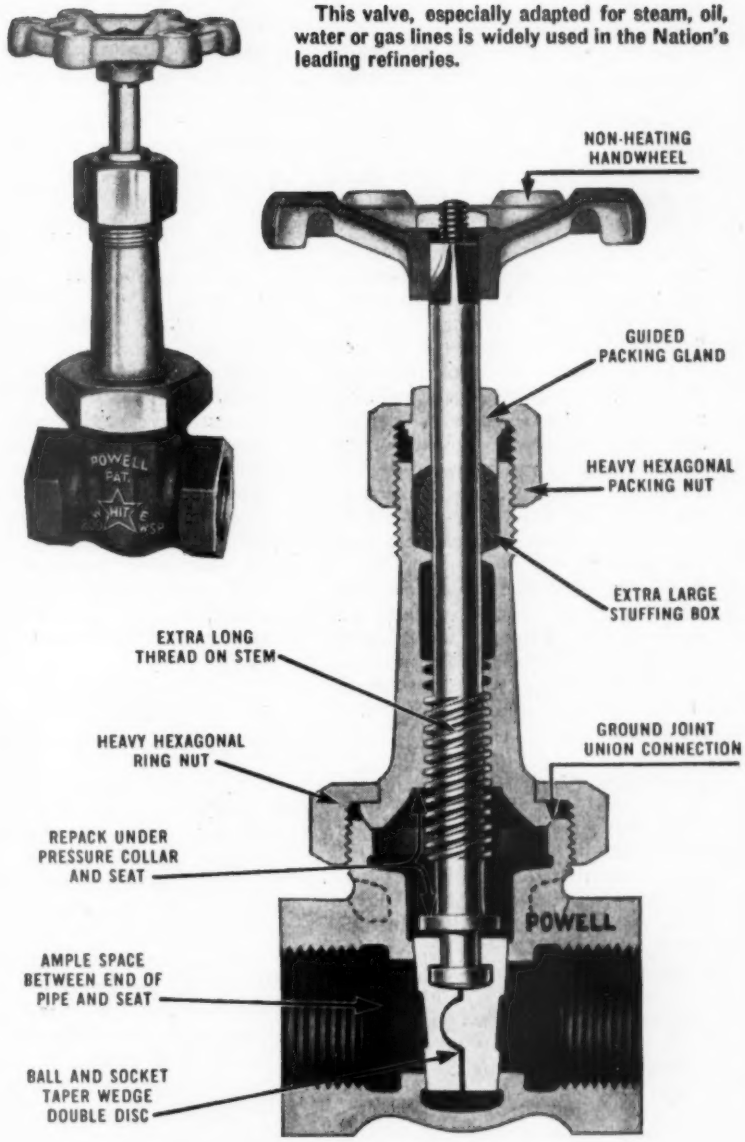
NON-HEATING HANDWHEEL
GUIDED PACKING GLAND
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EXTRA LARGE STUFFING BOX
EXTRA LONG THREAD ON STEM
GROUND JOINT UNION CONNECTION
HEAVY HEXAGONAL RING NUT
REPACK UNDER PRESSURE COLLAR AND SEAT
AMPLE SPACE BETWEEN END OF PIPE AND SEAT
BALL AND SOCKET TAPER WEDGE DOUBLE DISC
POWELL
POWELL PAT.
WHITE STAR WSP

Fig. 375
BRONZE "WHITE STAR" GATE VALVE

POWELL VALVES

erally speaking, are not set up to handle the intricacies of making and selling a variety of chemical products. This accounts for joint arrangements such as the one just announced."[4]

In announcing the new company, W. S. S. Rodgers, chairman of the board of The Texas Co., had the following to say:

"The importance of petroleum gases as raw materials for the production of chemical substances is being increasingly appreciated. Great strides have been made in this field during the war. Many constituents of petroleum gases which were formerly by-products at oil refineries are now in demand as raw materials. We have, therefore, established the Jefferson Chemical Co., Inc., to explore this field and produce from petroleum and petroleum gases such chemicals and chemical products as are likely to be in demand by various consuming industries."[5]

As indicated by the earlier quotation, petroleum chemical economics are indeed complex. Certain petroleum companies—such as Shell and Standard of New Jersey—have seen fit to carry out their own production and sales in wholly-owned subsidiaries, while others—such as Phillips and Continental—have taken steps similar to that now announced by The Texas Co. No detailed discussion of the factors involved in such decisions can be given here; some of these have recently been described elsewhere.[6] It is certainly evident, however, that petroleum companies in general are awake to the advantages of petroleum chemicals production and that more of them will follow one or the other of the two obvious methods of entering the field.

Synthetic Organic Chemicals

A recent report of the United States Tariff Commission[7] has revealed some interesting facts on the production of synthetic organic chemicals from petroleum. According to this report, some 1,564,914,665 pounds of chemical raw materials were derived from petroleum in 1943, an increase of approximately 500 million pounds over 1942.

These "raw materials" included 13,915,900 pounds of cresylic acids, 17,341,192 pounds of naphthenic acids, 103,091,279 pounds of butadiene, 166,224,385 pounds of ethylene, 394,620,200 pounds of C_3 hydrocarbons, 668,496,079 pounds of C_4 hydrocarbons, and 201,225,630 pounds of miscellaneous materials including benzene, xylenes, etc., but not including toluene.

In regard to the latter, which was listed elsewhere in the report, it was stated that "the total output of toluene from all sources was 164 million gallons in 1943, compared with 43 million gallons in 1942. This increase was due chiefly to the greater output from petroleum plants (excluding plants under Ordnance control)." In other words, production of toluene from petroleum in 1943 greatly exceeded 100 million gallons, since most Ordnance plants (some larger than 50 million gallons per year) also obtain their toluene from petroleum.

One very significant fact revealed was the reliance on petroleum raw materials of the "surface-active agents" industry. Of the 40,095,665 pounds of "cyclic" synthetic detergents, wetting agents, and similar materials produced in 1943, some 33,224,079 pounds were "sulfonated petroleum compounds," while 6,681,376 pounds of the 45,944,276 pounds of "noncyclic" surface active agents also produced were also sulfonated petroleum materials. The chemical industry has never before revealed that it depends upon petroleum for nearly half of the production of such substances, a few examples of which were recently discussed in this feature.[8]

Among other statistics were those for the following chemicals, derived in large part from petroleum: styrene, 97,654,711 pounds; acetic anhydride, 460,425,849 pounds; amyl acetates, 11,498,926 pounds; amyl alcohols, 12,072,725 pounds; chloroparaffins, 49,734,294 pounds; ethylene dichloride, 115,693,224 pounds; ethylene glycol, 186,834,068 pounds; and methyl chloride, 11,451,086 pounds.

It was stated that 6,636,578 pounds of "cyclic" gasoline anti-oxidants and inhibitors were produced in 1943, although these probably were not produced from petroleum itself in any quantity.

"The production of cyclic resins was 381 million pounds in 1943, a new high, compared with 297 million in 1942 and 348 million in 1941." In regard to noncyclic resins, many of which are produced from petroleum raw materials, production in 1943 "was 273 million pounds of which the noncyclic alkyd resins accounted for 50 million pounds and urea-formaldehyde for 54 million pounds. The production of the other principal noncyclic resins, such as polyvinyl chloride, acrylate, polyterpene, and petroleum resins amounted to 154 million pounds, a marked increase over the output of 87 million pounds in 1942."

It is obvious that most of these figures were surpassed in 1944. The Tariff Commission renders a valuable service in keeping the nation informed of the latest trends in chemical production, and it may be expected that this service will be expanded beyond prewar levels when the need for wartime secrecy no longer exists.

Automobile Developments

The petroleum industry and the general public alike continue to evidence great interest in news emanating from Detroit, where preliminary measures toward resumption of vitally-needed automobile production are still in progress, although the date when cars will again roll from production lines has been postponed by events in Europe.

In regard to postwar production, a recent statement by Henry Ford II has attracted considerable attention[9]. According to Mr. Ford, his company is pointing toward a goal of 2,000,000 cars per year after the war. "Face-lifted" 1942 models will appear three to four months after the "go ahead" is given, but the publicized low-priced cars will not be on the market for 12 to 18 months after manufacturing is resumed. Ford's postwar line will include a new Ford as well as the two prewar Ford models, a new Mercury in the lower middle-priced bracket, and two Lincolns, one high priced and one lower. The Lincoln Zephyr will not be manufactured.

Mr. Ford states that one-sixth or one-seventh of total production will probably consist of the new, cheaper Ford, or 300,000-400,000 in a 2,000,000 car year. In regard to this new car, Mr. Ford said that "the kind of car we have in mind would be a full-sized automobile with all of the built-in conveniences one gets in the regular models. There would be a certain conservation in weight and space, made possible through more careful engineering and design. We are hoping to price this car at somewhere around 15-20% lower than the lowest-priced model Ford after the war."

This would mean that the car would sell for a little less than the regular prewar model, for Mr. Ford believes that regular models will be priced higher than prewar levels by 10 to 20%. He believes that the new car will probably get about 28-30

[4] Anon., *Wall Street Journal* CXXIV, No. 130, 15 (1944), "American Cyanamid."

[5] Anon., *NATIONAL PETROLEUM NEWS* 36, No. 50, 36 (1944), "Joint Texaco-Cyanamid Setup for Chemicals Announced."

[6] Wakeman, R. L. and Weil, B. H., *NATIONAL PETROLEUM NEWS, Technical Section*, 35, No. 22, R-264 (1943), "ABC of Chemical Derivatives from Petroleum. VII. Basic Economics."

[7] Anon., *Preliminary Report on Production and Sales of Synthetic Organic Chemicals in the United States*, 1943, United States Tariff Commission (Washington), November, 1944.

[8] *NATIONAL PETROLEUM NEWS, Technical Section*, 36, No. 49, R-881 (1944), "Keeping Up With the News—Petroleum Soaps."

[9] Anon., *NATIONAL PETROLEUM NEWS* 36, No. 50, 13 (1944); *Wall Street Journal* CXXIV, No. 131, 4 (1944).

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miles per gallon of gasoline. Ford does not plan to make either airplanes or tires after the war, he stated, but may use some of its present facilities to manufacture farm equipment.

Postwar prices are troubling both Washington and the industry. The OPA has asked the automobile companies for detailed costs of automobile manufacture. It is reported that the companies are reluctant to release such figures since they would reveal data showing the basis for various individual competitive advantages.

OPA Administrator Bowles has stated as a "curbstone opinion" that a five per cent increase over 1941 car prices ought to suffice for postwar cars, but it is believed that this is a "horse trading" guess. Costs of manufacture are said to be up 15-25%, which figures would be increased if per-hour wages are raised further. Labor costs are said to be up 25-50% in Detroit, or an average of 30%, while materials are said to cost 10 to 15% more than in 1941.

The petroleum industry has a vital stake in the future of the automobile industry which provides the vehicles that, in 1941, consumed by far the larger part of the 26 billion gallons of gasoline produced. Future developments will be watched with more than interest.

Carbon Disulfide

The Pure Oil Co. has recently announced the development of a catalytic process for the synthesis of carbon disulfide from methane and sulfur, which are reacted at 925-1300°F.[10] Yields of carbon disulfide over certain catalysts are said to approximate 100% of the theoretical under suitable reaction conditions, and the product is said to be obtained in 99.5+% purity after separation of hydrogen sulfide by distillation. Catalysts are not specified, but it is said that those developed remain active for long periods of use.

The greatest use of carbon disulfide today—calling for over half of total production—is in the manufacture of viscose rayon "by the action of carbon disulfide and caustic soda on cellulose," followed by regeneration of the pure cellulose in continuous strands as the solution is forced through a spinneret into an acid bath. Viscose rayon, incidentally, is the type most in use today, although cellulose acetate rayon has superior properties for certain uses.

Carbon disulfide is also an important solvent, used "for the extraction of oils, fats, waxes, and other substances from a variety of materials. Other applications include its use in the vulcanization of rubber, the manufacture of carbon tetrachloride, as an insecticide, and in the production of xanthates for use in the flotation of ores.

Present commercial methods of producing carbon disulfide involve the reaction of special (hence expensive) grades of charcoal at temperatures of 1450-1850°F. These temperatures are said to result in the rapid deterioration of the retorts used in one scheme, while the electrothermal method of production involves high consumption of electrical energy.

Pure Oil does not claim that the basic reaction involved in its process is new; rather, it points to the fact that previous reactions between methane and sulfur to yield carbon disulfide have required temperatures above 1300°F. and that the presence of hydrogen in outlet gases poses an additional separation problem. Another similar reaction, between methane and hydrogen sulfide, is said to require a temperature of 1475-1850°F. and to give only fair yields.

It would appear that Pure Oil's process is not yet in commercial practice, for the article quoted[10] states that "the Pure Oil Co. is collecting further engineering data on commercial operation of this process."

It is interesting to note that another source[11] reports that the production of carbon disulfide is increasing and that the foremost producers are building new plants. If Pure Oil finds that its process can compete with existing methods, its discovery "may well add another chemical to the ever-increasing number of chemicals that are gradually finding their origin in the barely tapped potentialities of petroleum."

Synthetic Ammonia

In the early days of the war, considerable attention was focused on the necessity of increasing domestic production of synthetic ammonia to meet the wartime demands for nitrogen-based explosives. Ammonia synthesis requires both nitrogen and hydrogen, and it was at once evident that the most economical and abundant source for the hydrogen needed for an expanded program was natural gas.

Two general methods exist for the commercial synthesis of hydrogen from the lower hydrocarbons found in natural and refinery gases: (1) pyrolysis, which also yields carbon, usually as coke or, in some cases, carbon black, and (2) the catalytic methane-steam reaction, used by the petroleum industry for several years for the production of the hydrogen needed to hydrogenate butylene dimers and codimers to yield isooctanes. Both of these methods were pressed into service, especially the latter, and plant after plant for ammonia synthesis was announced in 1941 before censorship prohibited further specific public releases.

There is no question of the need for these plants as long as the war continues, but their postwar disposal is a problem which has attracted attention from many quarters.

The Department of Agriculture, for instance, has recommended the conversion of 40% of the Government's ammonia plants—250,000 to 300,000 tons per year—to the production of nitrogenous fertilizers and the maintenance on a standby basis of the remaining capacity not required by industry. The first part of this plan is attacked from several aspects by various "chemical experts," who believe that the Government would thereby flood the market.

They also point to the need for remembering the "good neighbor policy" in relation to Chilean sodium nitrate and to the fact that ammonia capacity can be converted to the production of methanol, a substance which may be needed in greater quantities after the war. The chemical industry is much afraid that the issue will become a political football.

The capacity of Government-owned synthetic ammonia plants has been estimated[12] at 760,000 tons per year of fixed nitrogen, while the capacity of all private plants is said to total 690,000 tons per year. The Department of Agriculture has released some estimates on postwar demands for fixed nitrogen; these vary from 1,190,000 tons for "extremely favorable conditions" to 1,040,000 tons for "moderately favorable conditions" and 675,000 tons for "unfavorable conditions;" these figures compare with a 1936-1940 average of 528,680 tons.

In regard to ownership of the new plants, it appears likely that TVA will operate the new plant at Muscle Shoals and that Mathieson Alkali will take up the DPC option on its plant at Lake Charles; these two plants have a combined capacity of over 100,000 tons per year. If a number of the plants are converted to methanol production, it is believed by the nitrogen industry that there may be room for the production of such DPC plants as are now operated by Lion Chemical Co., Commercial Solvents, the Military Chemical Co., etc. The Department of Justice is said to be eyeing option contracts and it is believed that it will object to the purchase of Government-owned plants by du Pont or Allied Chemical.

[10] Folkins, H. O. and Miller, E., *Pure Oil News* 27, No. 7, 14 (1944), "Carbon Disulfide, A Chemical From Petroleum."

[11] Stenerson, H. W., *Chemical and Engineering News* 22, No. 22, 2060 (1944), "Behind the Markets."

[12] Anon., *Business Week*, No. 797, 21 (1944).

Polymerization of Mixtures of 1,3-Butadiene With 2-Butene and with Pentane by Sodium*

By I. V. Rokityanskii and M. Yu. Lekakh

AUTHORS' CONCLUSIONS

1. In polymerization of mixtures of 1,3-butadiene with 2-butene in the presence of sodium, 2-butene acts as an agent limiting the growth of the polymer chains and partly participates in the formation of polymers.

2. The yield of polymers from mixtures with a butadiene concentration of from 10 to 36% amounted in the experiments being reported to 116-135% on the initial 1,3-butadiene. The lower the concentration of butadiene in the mixture and the higher the content of 2-butene, the higher is the yield of polymer on butadiene.

3. In the process of polymerization of 1,3-butadiene in mixture with 2-butene, a mixture of products of different extent of polymerization is formed. Low polymer forms of the general formula $(C_4H_6)_nH_2$ have been isolated in which n amounts to 2,3 or 4.

4. In polymerization of 1,3-butadiene in mixture with a saturated hydrocarbon, pentane, the yield of polymers was found to correspond to the initial content of butadiene. The polymers show a higher molecular weight than those obtained in mixture with 2-butene. No low polymer volatile substances are formed in marked quantities.

5. When a polymerization temperature of 60° was used in the experiments under report, the reaction was completed within 1-2 days. This method may, therefore, be used for isolation of 2-butene completely free of 1,3-butadiene.

THE problem of participation of olefins in the polymerization of isoprene and its homologs by sodium was raised by Ostromyslenskii [1]. He polymerized isoprene in mixture with trimethylethylene or isobutene and obtained polymers of a consistency ranging from solid to perfectly liquid, depending upon the concentration of olefin. The higher was the concentration of the latter, the more fluid was the polymer. The same was observed by him in polymerization of mixtures of 1,3-butadiene and isobutene. The polymers obtained from isoprene or its homologs in the presence of olefin hydrocarbons were termed by him combined rubbers. No combined rubbers were formed by 2,3-dimethyl-1,3-butadiene. This hydrocarbon forms in the presence of butenes, pentenes and hexenes an ordinary instead of a fluid polymer [1].

The change in the properties of the polymers of isoprene formed in the presence of pentene is explained by Ostromyslenskii by participation of the pentene in the polymerization, forming a saturated radical:

$$-CH_2C(CH_3)=CHCH_2 \ldots \ldots -C(CH_3)_2CH(CH_3)CH_2C(CH_3)=CHCH_2- \quad (1)$$

In support of this contention, he pointed out that rubber adds the less bromine the more pentene was contained in the initial mixture with isoprene.

This article is the first of a series of translations from Russian scientific literature to be published in the Technical Section of NATIONAL PETROLEUM NEWS. With the co-operation of the Petroleum Division of the American Chemical Society these articles have been selected from Russian journals as reporting on research work of interest to petroleum technologists in this country. Translations have been made by Dr. J. G. Tolpin of Universal Oil Products Co., Chicago.

The facts and opinions presented in these translations are solely those of the original authors. Neither Universal Oil Products Co. nor the Petroleum Division of the American Chemical Society necessarily endorse the statements made.

Koblyanskii, Ozerov and the authors of the present article investigated [2] the effect of the surface of sodium and the concentration of 1,3-butadiene in mixtures with 2-butene on the properties of the obtained polymers and found that with reduction of the concentration of butadiene in solution, keeping the weight proportion of butadiene per unit surface of sodium constant, the relative viscosity of the polymer is reduced. With increase of the surface of sodium, the concentration of butadiene remaining constant, the relative viscosity of solutions of the polymer also decreased. Thus, the increase of the surface of sodium and reduction of the concentration of butadiene led to formation of polymers with shorter chains.

The problem of participation of olefins in the reaction of polymerization of butadiene and its homologs by alkali metals has, in addition to general theoretical significance, also a practical interest in connection with preparation of 1,3-butadiene from alcohol by the method of S. V. Lebedev [3], since the reaction product obtained in this process contains, along with butadiene, considerable quantities of 2-butene.

The object of the present study consisted in determination of possible participation of 2-butene in the polymerization of butadiene with sodium.

The experiments were carried out at 60°C, using a concentration of butadiene in 2-butene ranging from 10 to 36%. For the sake of comparison, experiments were also carried out in which butadiene was polymerized in mixture with a saturated hydrocarbon, namely, pentane. The polymers obtained from mixtures with 2-butene were glycerin-like fluids of varying extent of mobility, depending upon the concentration of butadiene in the initial mixture. The lower was the concentration of butadiene, the more liquid was the polymer.

It was established that the polymer consisted of compounds of varying extent of polymerization. Low polymers were isolated that could be vaporized under reducd pressure, the extent of polymerization of which, n, could be expressed by 2, 3 and 4. Isolation of the higher polymer homologs with $n = 5$, 6, 7, etc. was not included in the scope of this work.

Precise determination of the yields of polymers on the initial 1,3-butadiene showed that for investigated concentrations of butadiene the yields were from 116 to 135%. The lower was the concentration of butadiene in 2-butene, the higher was the yield of polymer. The low polymers were contained in amounts of from 16 to 42% on the total polymer. With reduction of the percentage of butadiene in the mixture the amount of low polymers increased and that of the high polymers decreased.

Polymerization of butadiene in mixtures with pentane of the same concentrations as in mixtures with 2-butene gave polymers of comparatively high molecular weight containing no low polymer forms. The yield of polymers on the initial butadiene amounted to approximately 100%.

The above data indicate that 2-butene behaves differently from pentane and apparently participates to some extent in polymerization of butadiene with sodium. Preliminary experiments established that 2-butene does not undergo any marked change when heated with sodium for 2-3 days at 60°C. The participation of 2-butene in the formation of polymers was first explained on the basis of Ostromyslenskii's view, i.e., that organosodium

*A complete translation from Russian of the original article which appeared in *Sinteticheskii Kauchuk* (*Synthetic Rubber*), 1936, No. 9, pgs. 6-12. Translation is by Dr. J. G. Tolpin, Universal Oil Products Co., Chicago.

TABLE 1

Sample number	Weight of butadiene, grams	Weight of 2-butene, grams	Weight of sodium, grams	% butadiene on the mixture	Duration of heating at 60° C, hours	Yield of polymer		Yield of volatile low polymers (by pumping at —100°C and 3 mm. pressure—	
						grams	% on butadiene	grams	% on total yield of polymer
					EXPERIMENT 1				
1	3.7601	28.7069	0.4246	11.58	60	4.9138	130.7	1.5386	31.31
2	3.7717	28.7833	0.4512	11.58	20	5.0308	133.4	1.7088	33.96
3	5.5202	13.2806	0.4284	29.36	20	6.4864	117.5	1.3580	20.93
4	5.9075	10.1345	0.4266	36.86	20	6.8594	116.1	1.1502	16.76
					EXPERIMENT 2				
5	1.6110	14.2634	0.2078	10.14	48	2.1506	133.49	0.9112	42.36
6	1.6726	11.7158	0.2032	14.27	48	2.2551	134.80	0.8855	39.2
7	3.2756	12.4856	0.2114	20.77	48	4.1402	126.32	1.3548	32.72
8	2.3634	12.2054	0.2042	19.35	48	3.0284	128.13	1.0376	34.26
9	3.0226	10.0566	0.2200	30.05	48	3.6462	120.63	0.9776	26.81

Polymerization of Mixtures

compounds of butadiene formed as postulated by Ziegler [4] are capable of adding 2-butene:

$$NaCH_2CH{=}CHCH_2Na + CH_3CH{=}CHCH_3 \rightarrow NaCH_2CH{=}CHCH_2CH(CH_3)CHNaCH_3 + CH_2{=}CHCH{=}CH_2 \rightarrow NaCH_2CH{=}CHCH_2CH(CH_3)CH(CH_3)CH_2CH{=}CHCH_2Na, \text{ etc.} \quad (2)$$

Under the action of moisture, these organometallic compounds could decompose and as a codimer formed in accordance with the above equation, the hydrocarbon C_8H_{10} would be formed:

$$NaCH_2CH{=}CHCH_2CH(CH_3)CHNaCH_3 + H_2O \rightarrow CH_3CH{=}CHCH_2CH(CH_3)CH_2CH_3 \quad (3)$$

Low polymer forms of the composition $(C_4H_6)_2H_2$, $(C_4H_6)_3H_2$ and $(C_4H_6)_4H_2$ were actually isolated by the authors containing only one double bond per 4 carbon atoms, which is seen from the data of elementary analysis, bromine numbers and molecular refraction. Bromine numbers of the polymers formed in mixtures with pentane and 2-butene (after removal of low polymers forms in the latter case) do not markedly differ from each other, although both show values lower than those required by theory. It is to be pointed out that iodine numbers obtained by other authors [5] for sodium-butadiene polymer amounted only to 66-68% theor., which apparently is due to the structure of the sodium-butadiene polymer.

On the basis of the low polymer forms of the general formula $(C_4H_6)_nH_2$ isolated, as well as high polymer forms, a general conclusion may be drawn that Ostromyslenskii's view concerning participation of pentene in the formation of the isoprene polymer in the form of a saturated radical is not applicable to polymerization of mixtures of butadiene and 2-butene in the presence of metallic sodium.

Against the above outlined mechanism of polymerization of butadiene with participation of 2-butene speaks also the fact that when the tubes were opened and 2-butene removed under conditions excluding access of moisture and decomposition of organosodium compounds, low polymers of the composition $(C_4H_6)_2H_2$ and $(C_4H_6)_3H_2$ could be isolated by pumping. Formation of hydrocarbons free of sodium may take place according to this scheme only as a result of decomposition of organosodium compounds by water. Thus, in the process of polymerization of butadiene in mixtures with 2-butene, low polymers of the general formula $(C_4H_6)_nH_2$ are formed which are free of sodium. This can, apparently, take place if sodium of the organometallic compounds is substituted by hydrogen of the molecule of 2-butene:

$$(CH_2CH{=}CHCH_2)_nNa_2 + 2CH_3CH{=}CHCH_3 \rightarrow (CH_2CH{=}CHCH_2)_nH_2 + 2CH_3CH{=}CHCH_2Na \quad (4)$$

The compound $CH_3CH{=}CHCH_2Na$, being a sodium-organic compound, is apparently capable of causing polymerization of butadiene:

$$CH_3CH{=}CHCH_2Na + CH_2{=}CHCH{=}CH_2 \rightarrow CH_3CH{=}CHCH_2CH_2CH{=}CHCH_2Na, \text{ etc.} \quad (5)$$

The growth of the chain will continue until broken by a 2-butene molecule.

The polymers formed by Equations 4 and 5 will be expressed by the general formula $(C_4H_6)_nH_2$. Their structure may differ depending upon whether addition of butadiene occurs in positions 1,2 or 1,4 or mixed. The location of the metal atom in butenylsodium will also affect the structure of the polymers formed according to Equation 5.

The correctness of the assumption relative to participation of 2-butene in polymerization of butadiene by sodium may be verified by direct study of the action of alkyl alkalies on a definite olefin [6]. Research on this subject is being continued.

TABLE 2

Fraction number	Boiling range, °C.	Weight of the fraction, grams	Per cent	Mol. wt. determined cryoscopically in benzene	Bromine number (Rosenmund[6])
1	90-110 under atm. pressure	1.2)		115.0	249.3
2	110-130 under atm. pressure	11.6)		112.0	283.0
3	130-160 under atm. pressure	2.18)		.....	.....
4	160-180 under atm. pressure	1.10)	10.78	150.6	.....
5	50-70 under 4 mm. pressure	7.60)		164.0	270.0
6	70-100 under 4 mm. pressure	3.20)		.....	.....
7	100-140 under 4 mm. pressure	4.80)		229.0	271.0
8	140-150 under 4 mm. pressure	1.10)		.....	.....
9	Polymer boiling over 150° and 4 mm. pressure	265.15	89.22	.....	.....

Experimental Part

Butadiene was reclaimed from its tetrabromide melting at 116-117°C with zinc in aqueous alcohol by the method of Thiele. Technical 2-butene was used after being kept in contact with sodium at 60°C to complete polymerization of butadiene, followed by distillation under a dephlegmator, collecting the fraction boiling at 0-1.5°C. The so refined 2-butene was perfectly free of butadiene. In the experiment 2 (Table 1) 2-butene was used obtained from its dibromide, b.p. 158-160°C, by regeneration with zinc dust in alcohol under normal conditions. The sample of pentane used (Kahlbaum) was free of unsaturated compounds.

The first series of experiments aimed at investigation of possible participation of 2-butene in polymerization. This was done by quantitative determination of the initial butadiene and obtained polymerization products. The experiments were carried out in glass tubes. The mixtures of butadiene and 2-butene were compounded directly in the tubes. A sample of sodium wire of diameter 1.0

mm. was first placed into a dry tube filled with nitrogen, the tube was cooled in a Dewar vessel with carbon dioxide and charged with 2-butene and with butadiene. After each operation, the tube was sealed and weighed to 0.001 g.

The polymerization was effected at 60-60.5°C. The samples were kept in thermostats for 20-60 hours, during which time the solutions of the polymers acquired a dark red color which was the more intense the higher was the concentration of butadiene in the mixture within the limits tested, i.e., 10 and 30%. After opening the tubes, the color sometimes persisted for a very long time. The reaction was completed within 1-2 days and in the 2-butene distilled off not even traces of butadiene could be found.

Preparation of Pure 2-Butene

Polymerization under these conditions may serve as a method of preparation of pure 2-butene containing no butadiene. This method of refining of 2-butene was investigated on a previous occasion at the Synthetic Rubber Plant B [7] and samples were obtained containing at the average 0.5-3% butadiene. It may be pointed out that in distillation of 2-butene after polymerization of butadiene, volatile low polymer forms $(C_4H_6)_2H_2$ may vaporize, the bromides of which may be taken to be tetrabromide of 1,3-butadiene.

The yields of polymer were determined as follows: the tube was opened, 2-butene distilled off first without heating and then at 100°C on the oil bath under a reflux condenser, the inside tube of which consisted of the narrow end of the reaction ampule, and which was cooled with ice water. It was found that at 100°C 2-butene was completely removed within 30 minutes. The completion of its removal was verified by pumping under 3 mm. pressure at 100°C. The volatile low polymers were retained in a coil cooled with carbon dioxide in a Dewar vessel to −70°C. The condensate was heated to 80-90°C to remove possible traces of 2-butene and weighed.

Yields of 135% Obtained

The data of Table 1 reveal that the yield of polymer on butadiene amounts to 116-135%, depending upon the concentration of butadiene in the mixture. In the mixture containing 36.86% butadiene, the yield was 116.1%. That containing 10.14% gave 133.49%. The higher was the content of 2-butene in the mixture, the higher was the yield of polymerization products. The content of low polymer volatile forms obtained at 100°C and 2-3 mm. pressure varied from 16.76 to 42.36% on the total yield of polymerization products and was inversely proportional to the content of butadiene in the solution.

Since the yields of polymer exceed the initial amounts of butadiene charged, it may be regarded as established that

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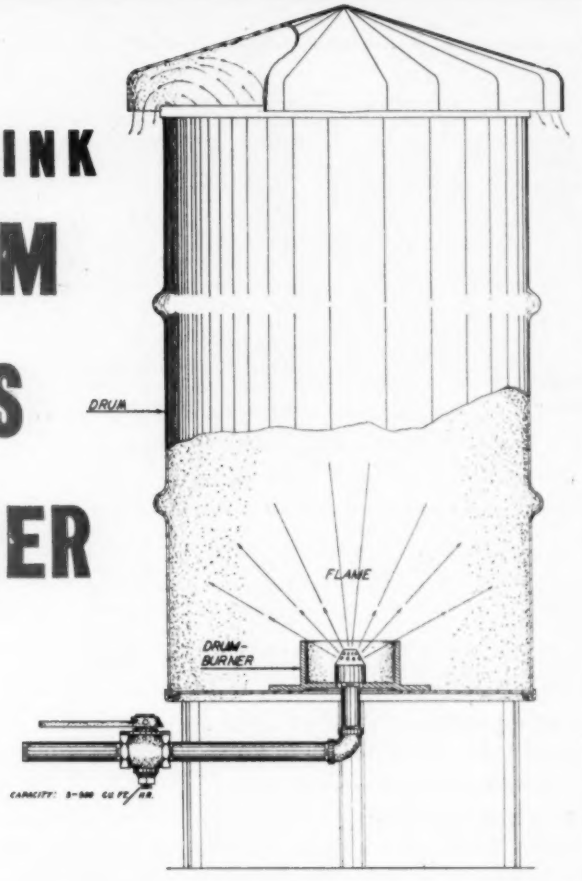

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TABLE 3

Fraction number	B.p. under atm. pressure, °C.	Weight of the fraction, grams	Mol. wt. determined cryoscopically in benzene	Bromine number Found	Bromine number Calculated	$d(20/20)$	$n(20/D)$	MR_D Found	MR_D Calculated
1_2	110–113	2.1	112.0	279.6	290.0	0.7361	1.4262	38.30	38.2
2_2	113–116	4.3	113.2	286.4	....	0.7345	1.4262	38.38	38.2
3_2	116–120	0.8	110.2	281.9	....	.....	.....	.....	....
			mol. wt. of C_8H_{14}, 110.1						

TABLE 4

Fraction number	B.p. under 7 mm. pressure, °C.	Weight of the fraction, grams	Mol. wt. determined cryoscopically in benzene	Bromine number Found	Bromine number Calculated	$d(20/20)$	$n(20/D)$	MR_D Found	MR_D Calculated
1	68–75	3.1	164.5	269.4	295.5	0.7891	1.4530	56.16	56.21
2	75–83	1.6	166.6	.....	....	.....	1.4565	.....	.....
			mol. wt. of $C_{12}H_{20}$, 164.2						

TABLE 5

Sample number	Weight of butadiene, grams	Weight of 2-butene, grams	Weight of sodium, grams	% butadiene on the mixture	Duration of heating at 60°C, hours	% sodium on butadiene	Yield of polymer grams	Yield of polymer % on butadiene	Unreacted butadiene, %
1	5.3500	26.7085	0.4825	17.0	20	9.02	5.1725	96.65	2.36
2	3.000	29.3790	0.3280	9.2	48	10.93	2.9720	99.07	....
3	2.2428	19.8114	0.4970	11.70	48	22.15	2.2785	101.50	....

2-butene participates in the formation of polymerization products.

Investigation of Low Polymers

Fractional distillation under a dephlegmator of 300 g. crude polymer obtained by polymerization of 25-35% butadiene mixtures with 2-butene in the presence of 3-7% sodium in the form of a wire of 1.04 mm. diameter gave the data of Table 2. The fractions 2, 5, 6 and 7 were subsequently investigated in more detail.

Fraction 2 was a light liquid of peculiar odor. By repeated distillation it was separated into several fractions (Table 3). Analysis revealed that all these had a composition described by C_8H_{14} and constituted, apparently, mixtures of isomers of octadiene. Analysis of fraction 1_2, 110-113°C—Found: C, 87.01%; H, 12.74%. Analysis of fraction 2_2, 113-160°C—Found: C, 87.31%; H, 12.72%. Calculated for C_8H_{14}: C, 87.19%; H, 12.81%.

Fractions 5 and 6, boiling at 50-70°C and 70-100°C under 4 mm. pressure, respectively, gave in repeated distillations a hydrocarbon $C_{12}H_{20}$ with three double bonds (Table 4). Analysis of fraction 68-75°C and 7 mm.—Found: C, 87.89%; H, 12.19%. Analysis of the fraction 75-83°C and 7 mm.—Found: C, 87.71%; H, 12.07%. Calculated for $C_{12}H_{20}$: C, 87.72%; H, 12.28%.

Distillation of the fraction 7, Table 2, boiling at 100-140°C and 4 mm. pressure yielded 3.1 g. of a fraction 110-130°C and 7 mm. pressure which consisted of $C_{16}H_{28}$ with four double bonds and gave a bromine number 272.1. Analysis—Found: C, 88.25%, 88.15%; H, 11.79%, 11.98%. Calculated for $C_{16}H_{28}$: C, 87.99%; H, 12.01%; mol. wt. cryoscopically determined in benzene, 214.4; calculated, 218.2; $d(20/20)$, 0.8187; $n(20/D)$, 1.4661; MR_D, 73.46; calculated for $C_{16}H_{28}$ with four double bonds, 74.21.

Polymerization of Butadiene in Mixtures With Pentane

Experiments of polymerization of butadiene in mixtures with a saturated hydrocarbon, namely, pentane, were performed for comparison with the data obtained for mixtures with 2-butene. The method and the conditions of the experiments were the same as applied to mixtures of 2-butene and butadiene. As a result of polymerization, the solutions acquired a dark red color. The yields of polymers plus unsaturated butadiene amounted approximately to the content of initial butadiene (Table 5). The volatile low polymers could not be isolated, since the extent of polymerization was higher. Absence of volatile low polymers and agreement of the yields of polymer with the initial amount of butadiene used indicate that pentane as a representative of saturated hydrocarbons serves only as a solvent and does not participate in the formation of polymer products.

For a comparison of the polymers obtained in mixtures of pentane and 2-butene, the molecular weights were determined cryoscopically in benzene and the bromine numbers by the method of Rosenmund [8] (the sample of polymer was dissolved in 50 cc. chloroform). It follows from the data of Table 6 that the polymer prepared in the presence of 2-butene (a mixture containing 30.5% butadiene) had a molecular weight of 353, and after removal of the volatile compounds with 8 and 12 carbon atoms, 826.8. The molecular weights of the polymers obtained in the presence of pentane could not be determined by this method because of the slight depression of the freezing point.

Bromine numbers of some samples of polymer obtained from mixtures of butadiene with pentane and 2-butene showed almost no difference, although they were considerably lower than the theoretical values.

TABLE 6

Sample number	Diluent	% butadiene	% sodium on butadiene	Mol. wt. determined cryoscopically in benzene	Bromine number Found	Bromine number Calculated
1	Pentane	15.7	10.4	See (*)	235.0	296.0
2	Pentane	30.6	3.0	See (*)	231.2	296.0
3	2-Butene†	30.05	7.2	353.0	.....	.....

*Because of low depression (comparatively high mol. wt.) no reliable data could be obtained by this method.
†After removal of volatile low polymers with 8 and 12 carbon atoms.
‡Bromine number of the volatile fraction, 270.9.

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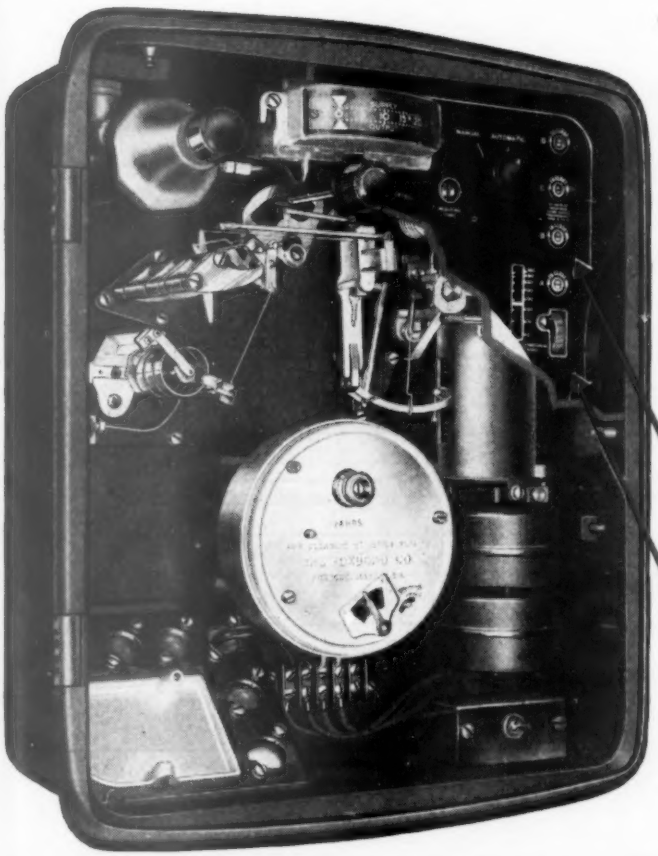

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Vibration in Compressor Plant Piping*

By M. L. Arnold**

THE use of compression equipment at high rotative speeds and high operating pressures has made many of us uncomfortably aware of a phenomenon called vibration, which arises specter-like and imparts the shakes to piping, designers, and operators. After once having been responsible for a condition of this kind, engineers dream of designing a plant which is entirely free of vibration.

The purpose of this article is to describe the avenues by which the engineer may be able to approach this Utopia. But, first, we will briefly discuss the mechanical effect of vibration on piping, the mechanics of vibration, and the origin of the forces causing vibration in compressor plant piping.

If piping is subjected to a stress statically applied, it will rupture only if the stress exceeds the ultimate tensile stress of the metal composing the pipe wall. However, if the pipe is subjected to repeated bending, such as occurs during vibration, rupture may occur even though the maximum stress in the metal has been far less than the ultimate tensile stress. Rupture of this type is referred to as fatigue failure.(1)

In general, fatigue failure due to vibration is most likely to occur in highly stressed portions of the piping system, such as expansion bends, than in less stressed portions such as straight runs. Failure will occur earlier if the magnitude, or amplitude, of the vibration is large than if the amplitude is small. It will occur at points where non-uniformities such as notches or changes in cross section occur, rather than in uniform sections of piping.

Some of these points are illustrated in Figs. 1, 2, and 3. Fig. 1 shows that the number of times a piece of steel can be bent before rupture occurs increases as the maximum bending stress decreases. The stress was varied from that shown on the figure to zero and back during each cycle. Such a curve is called an S-N curve. If a complete reversal of stresses had been effected during each cycle, that is, if the stresses had been varied from a tensile stress to a compressive stress of the same magnitude and back, the S-N curve would be parallel to the one shown, but at each point failure would have occurred at a lesser value of maximum stress. The value of the stress over the horizontal portion of the curve is referred to as the endurance limit of the material.

Fig. 2 shows the effect of various types of irregularities in cross sections upon fatigue strength. Irregularities of form such as holes, threads, notches, sharp shoulders, etc., when present in a pipe or other member may produce localized stresses. These stresses may be much greater than the stress calculated by the ordinary formulas of mechanics. For this reason irregularities in section must be considered in estimating the fatigue strength of piping.(2)

Fig. 3 illustrates the effect of maximum stress and stress range upon endurance strength. The ordinate is in percent of the ultimate tensile strength of ferrous metal and the abscissa is arbitrary. It

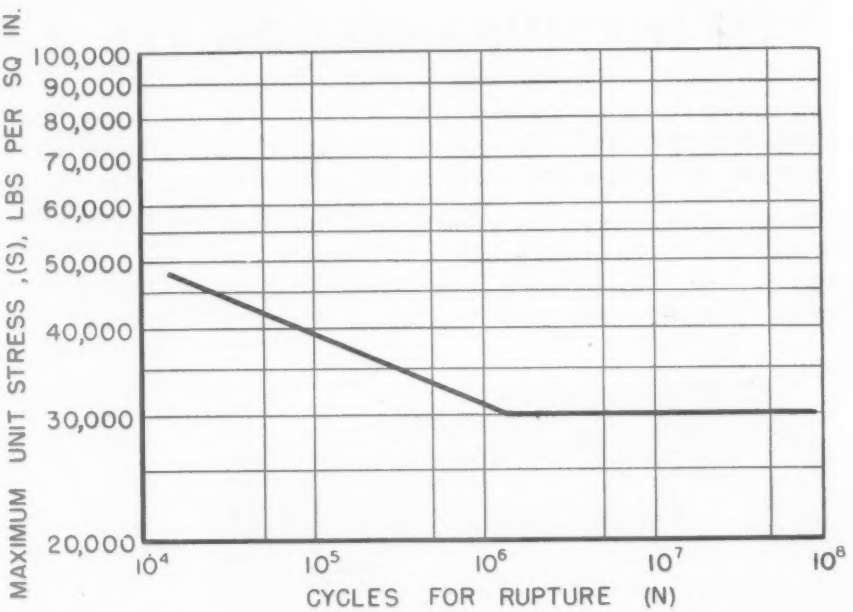

Fig. 1—Typical S-N diagram for a ferrous metal. (Reference—Johnson: Materials of Construction)

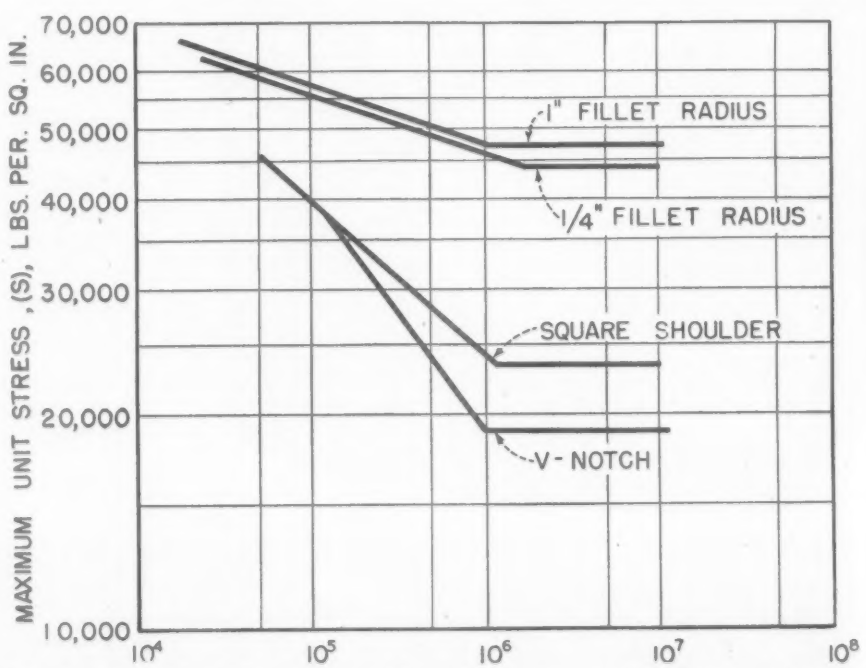

Fig. 2—S-N diagram for specimens of irregular cross section. (Reference—Johnson: Materials of Construction)

*Presented at the Dec. 7, 1944, monthly meeting of California Natural Gasoline Assn.

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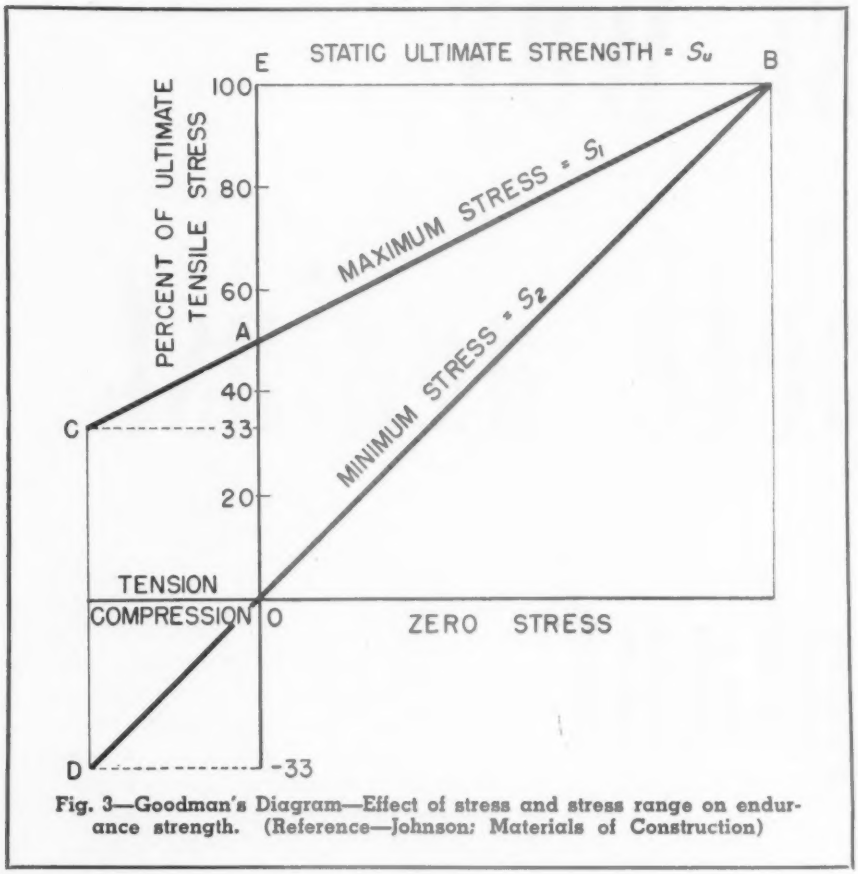

Fig. 3—Goodman's Diagram—Effect of stress and stress range on endurance strength. (Reference—Johnson: Materials of Construction)

is apparent that, if the maximum stress is high, only a small range of stresses can be tolerated during each cycle. If a complete reversal of stresses occurs, the maximum permissible stress is 33% of the ultimate tensile stress.[3] If the maximum stress is greater than that shown in the diagram, then the range between the maximum and minimum stress must be reduced by reducing the amplitude of the vibratory motion.

The simplest type of vibratory motion is known as free harmonic vibration.[4] It is the type of motion which would be described if a system composed of a weight suspended on a frictionless spring were set in motion in a frictionless medium and no external force acted upon it. If friction is present, either in the spring or in the medium, the resulting motion is called free damped vibration.

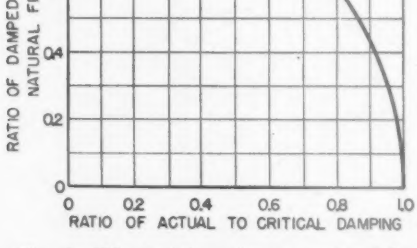

Fig. 4—Effect of damping on natural frequency of vibration. (Reference—Den Hartog, Mechanical Vibrations)

The maximum displacement of a vibrating member, such as the weight referred to is called the amplitude of the vibration. The movement from one position of maximum displacement, thru the mean position to the opposite position of maximum displacement and return to the original position is known as a cycle, the time required to complete one cycle as the period, and the number of cycles described per unit of time as the frequency.

If a system capable of vibrating is set in motion, and no retarding forces act upon it, the frequency at which it oscillates is known as its natural frequency of vibration. If the motion is retarded (damped), both the amplitude and the frequency of the motion are diminished.

If the retarding force is increased gradually, a value will be found for which the system will not vibrate but when displaced from its position of rest will slowly return to this position. The amount of damping just sufficient to effect this is called "critical damping".

The effect of damping on the natural frequency of vibration is given in Fig. 4. The ratio of the damped to the undamped natural frequency is shown as a function of the coefficient of damping. This coefficient is defined as the ratio of actual damping to critical damping. For the degree of damping ordinarily experienced, it can be assumed that the natural frequency is not affected.

In compressor plants we are interested not in free damped vibration but in forced damped vibrations. Forced damped vibrations result from the action of periodic forces upon a system susceptible to vibration. Examples of such disturbing forces are those resulting from the periodic explosions of the charge in power cylinders and from the periodic discharge of gas from a compressor cylinder. If the frequency of the periodic force is the same as the natural frequency of vibration of the system to which it is applied, the periodic force is said to be in resonance with the system.

In general, the preceding remarks and those which follow apply to any system in which the static deflection of a member is a linear function of the force applied. A piece of pipe with the ends supported is such a system. Fig. 5 shows the natural frequency of vibration of various sizes of pipe supported in this manner, for various distances between supports.

If a force is statistically applied to a section of piping supported as described, the deflection can be computed from the usual formulas for deflection of beams. However, when the force is applied periodically, the resulting deflection, or amplitude, may equal, exceed, or be less than the computed static deflection.

The ratio between the deflection obtained when the force is applied periodically and the deflection caused by the same force statically applied is called the magnification factor.

This factor is variable with the ratio of the frequency of the applied force to the natural frequency of vibration of the system and with the coefficient of damping of the system. The relationship is shown in Fig. 6. As shown by the figure, at resonance, a small disturbing force can cause a forced vibration of large amplitude.

If several disturbing periodic forces act simultaneously on a system, the

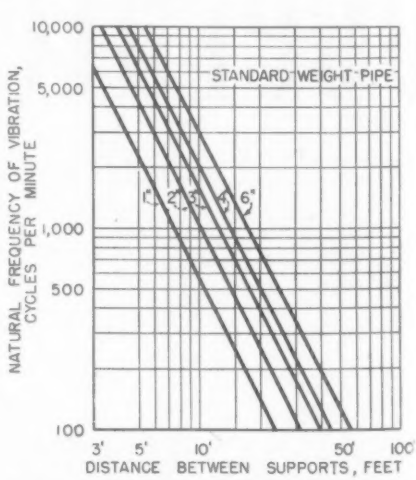

Fig. 5—Natural frequency of vibration of pipe with supported ends

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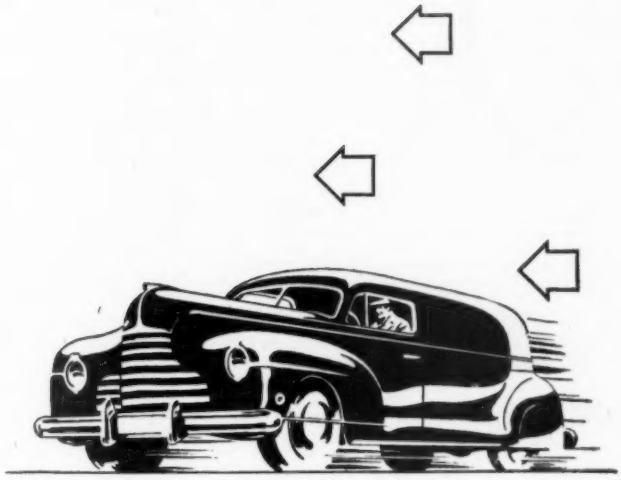

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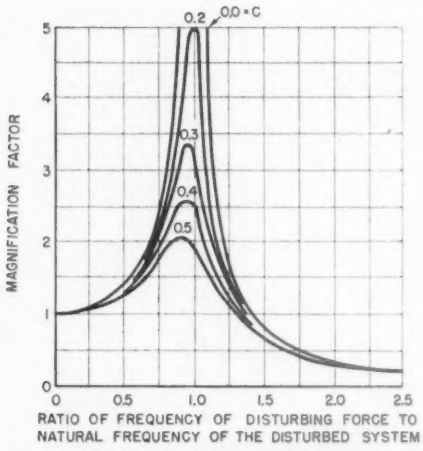

Fig. 6 — Magnification factor. (Reference — Marks: Mechanical Engineers Handbook, 4th Edition)

amplitudes of the forces add algebraically. If the forces are of different frequency, beat frequencies result. For example, if the two periodic forces shown in Fig. 7 act simultaneously on a system, the beat frequencies shown in Fig. 8 result.

The disturbing periodic forces in compressor plants with which we are concerned originate from two sources. These are the rotating and reciprocating parts of the engine and compressor, and the discharge of gas from the compressor cylinders.

The magnitude of the forces created by the moving parts depends largely upon the degree to which these parts have been counterbalanced. The frequency of the force is a function of engine speed and the number of cylinders.

These forces are transmitted as pressure waves thru the frame of the engine to the foundation and thence to the surroundings and piping. The pressure waves travel at a speed approximately equal to the velocity of sound in the material thru which the wave is being transmitted.[6]

The amplitude of the pressure waves is considerably reduced by damping during transmission. A further reduction in force occurs by reflection when the wave is transmitted from a material in which the velocity of propagation is high to one in which the velocity is lower. For example, at the interface between the cast iron bed plate and the concrete foundation, approximately 73% of the force of the wave is reflected back into the engine frame. The force is further reduced as the wave passes from concrete to dry earth. Even though these forces are greatly diminished before reaching the piping, they cannot be dismissed as possible causes of vibration. For it has been shown in Fig. 5 that at resonance, the magnification factor may approach infinity and very small forces cause vibrations of large amplitude.

The disturbance due to the periodic discharge of gas from the compressor cylinder is evidenced principally at points of change in direction of the piping. For when a fluid flowing thru a pipe is made to change direction, as at a tee, elbow, or pipe bend, a reactive force is created. The magnitude of this force is proportional to the mass velocity of the flowing fluid and to the change in direction.[8] Since the velocity of flow from a compressor cylinder varies periodically, a periodic reactive force is created when the gas is caused to change direction. The frequency of the force is a function of the speed of the compressor, the number of cylinders connected to the line, the crank angle between the cylinders, and whether the cylinders are single or double acting.[9]

This periodic discharge of gas is also sometimes responsible for the existence of abnormal pressures in compressor piping. This results from the formation of standing pressure waves in the piping. These are created by reflection when the length of a discharge pipe is such that its resonant frequency is equal to the frequency of the discharge of gas from the compressor cylinder. The resonant frequency of a pipe is a function of its length and the velocity of sound in the gas flowing thru it.[10]

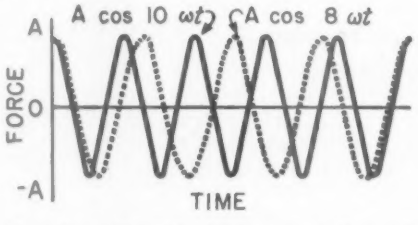

Fig. 7 — Graphical representation of force causing harmonic vibration. (Reference—Freberg & Kemler: Elements of Mechanical Vibration)

At this point we are in a position somewhat similar to that of a young man who has been sitting on a pier listening to a lecture on the theoretical aspects of swimming, such as the laws of gravity and buoyancy, but who has never been in the water. So suppose we all take a deep breath and prepare to try out some of the theory. But before actually taking the plunge, it might be well to briefly summarize the discussion so far, as follows:

1. Vibration in compressor plant piping is caused by periodic forces originating in the compression equipment.
2. These periodic forces are transmitted from the equipment to the piping either thru the foundations and surroundings or by means of the flowing gas.
3. The vibration resulting from the application of these periodic forces to the piping is most likely to be destructive if the frequency of the forces is approximately equal to the natural frequency of vibration of the piping.

This summary indicates that there are three avenues of approach to the solution of the problem of designing a compressor plant which will be free of troublesome piping vibration. These are as follows:

1. Design the compression equipment in such a way that all disturbing forces are eliminated.
2. Isolate the sources of disturbing forces from the piping system.
3. Design the piping system in such a way that it will not be affected by any of the periodic forces likely to occur.

These avenues will be explored one by one.

The problem of designing equipment which is free of disturbing forces we will leave to the equipment manufacturers. In a paper presented by Engleman and Chrzan, we were told of the extent to which it is possible to reduce engine unbalance.[5]

Forces due to unbalance can also be minimized by resorting to massive foundations. In this respect it has been stated that the soil on which a foundation rests adds considerably to the effective mass of the foundation because the mass of the soil, as well as the mass of the foundation, must be accelerated during lateral vibration.[11] This would indicate the desirability of compressor foundations having large spread footings.

The forces arising from the periodic flow of gas from the compressors will probably always be with us, unless reciprocating compressors are replaced

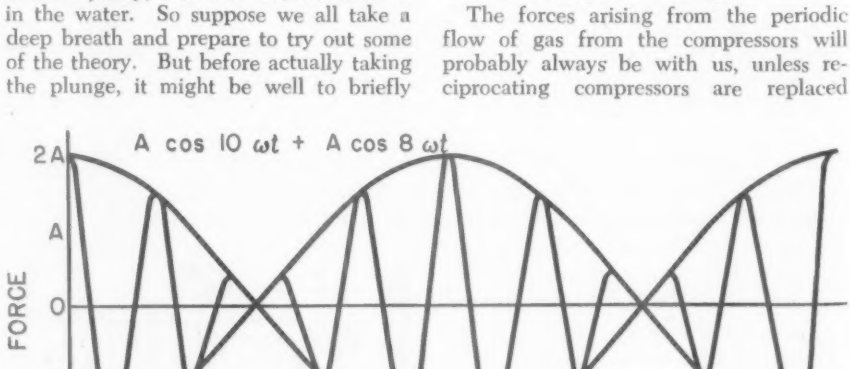

Fig. 8—Beat frequency resulting from simultaneous action of forces shown in Fig. 7. (Reference—Freberg & Kemler: Elements of Mechanical Vibration)

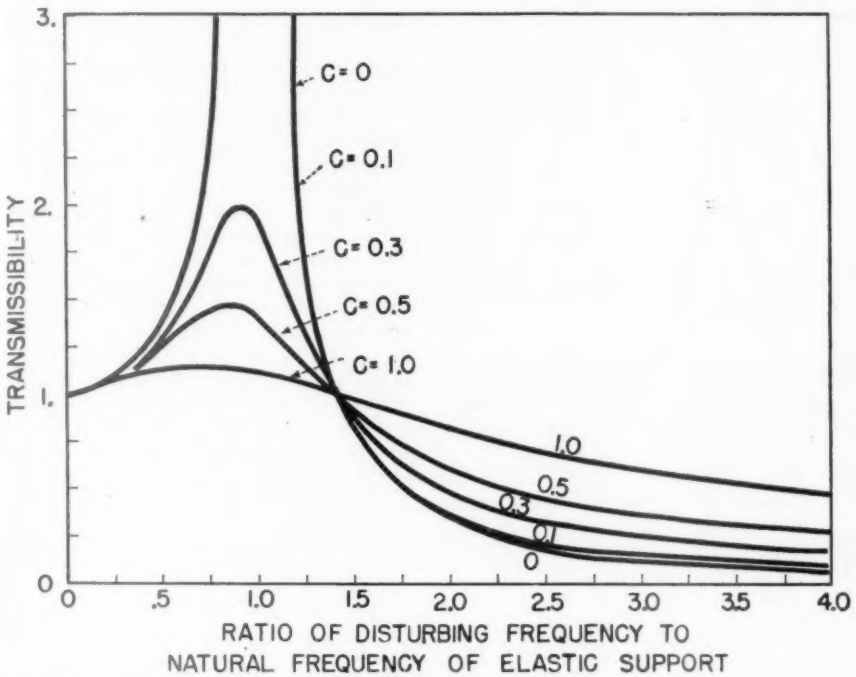

Fig. 9—Transmission of elastic supports. (Reference—Freberg & Kemler; Elements of Mechanical Vibration)

with units of the centrifugal or rotary type. The flow from a reciprocating machine can be improved, if instead of a single large cylinder several small cylinders are used, driven by throws uniformly spaced around the crankshaft. This will decrease the amplitude of the disturbance, but the frequency will be increased.

In other industries much progress has already been made along the second avenue of approach. It has been demonstrated that a source of disturbing periodic forces, such as a gas engine, can be isolated from its surroundings with almost any desired degree of completeness by mounting the machine on elastic supports. For small masses, springs, rubber, corkboard and felt supports are available. For large masses springs, or springs in combination with one of the other materials, are generally used. It is stated that machines weighing up to 450 tons have been satisfactorily isolated in this way.[12]

Buildings have been isolated from vibrations transmitted to foundations by erecting the columns on pads made of alternate layers of lead and asbestos.[13]

Great care must be used in designing elastic supports. If improperly designed, the forces transmitted to the surroundings may be magnified rather than reduced.

The ratio of the force transmitted thru an elastic support to the disturbing force is called the transmissibility of the support. The transmissibility is a function of the ratio of the frequency of the force being isolated to the natural frequency of vibration of the elastic support. Fig. 9 shows, for various damping coefficients, how this ratio affects the transmissibility. It is apparent that, unless the ratio is greater than 1.414, no reduction is accomplished; and that if the ratio is in the vicinity of one, the force transmitted to the surroundings is increased.

Damping is undesirable for ratios greater than 1.414 unless the disturbing force is of such a variable frequency that the ratio may approach one during a portion of the operation. In this case, a damping device must be used. It can be adjusted to come into action only in case the amplitude of the transmitted force exceeds a certain value.

Fig. 10 shows, for various disturbing frequencies and percentage reduction of force, the natural frequency required of the elastic support, and also the amount which the support must deflect statically when loaded with the machine which it is desired to isolate.

The theory of elastic engine supports has been discussed at length in a paper by Rosenzweig.[14]

As an alternate to isolating engines from the piping, piping can be isolated from the engines. If it is necessary to support piping from the engine foundations or from structures affected by engine vibrations, elastic piping supports can be used. These may be steel springs if the piping is suspended from a structure, and steel springs or rubber if the piping is supported from the foundation.

In this latter case, the piping can also be protected from pressure waves transmitted from the foundation by causing a portion of the force of the wave to be reflected back into the foundation. This is accomplished by interposing between the support and the foundation a layer of material in which the velocity of sound is low as compared to the velocity of sound in concrete. Examples of such materials are rubber, cork, and dry sand. If rubber is used approximately 80% of the force will be reflected back into the concrete.

The problem of isolating pipe bends from changes in velocity of the flowing fluid is more difficult. Some degree of uniformity of flow in the lines to and from the compressors may be attained by the use of apparatus similar to that used to muffle the exhaust from an engine. However, the problem is more difficult. A muffler attempts only to suppress vibrations in the audible sound range while here we are concerned with securing a constant flow velocity. It may be possible to solve the problem by acoustical methods.[16]

The third and final avenue of approach is careful, intelligent piping design. Supports should be spaced so that no part of the piping system has its natural frequency of vibration equal or

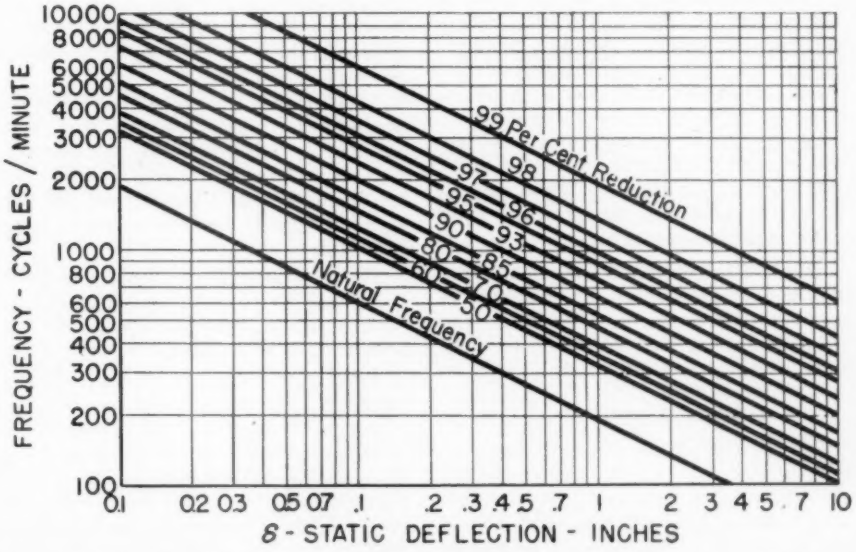

Fig. 10—Vibration isolation frequency—static deflection chart. (Reference—Freberg & Kemler; Elements of Mechanical Vibration)

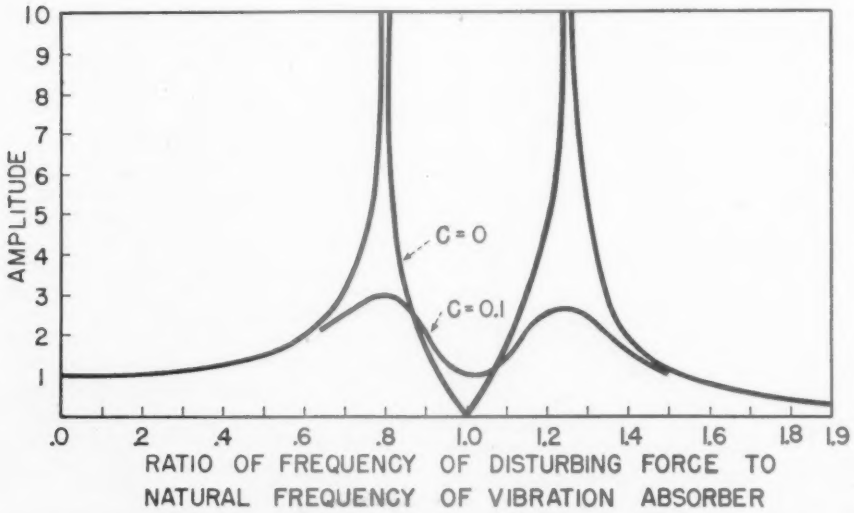

Fig. 11—Effect of dynamic vibration absorbers. (Reference—Freberg & Kemler: Elements of Mechanical Vibration)

nearly equal to the frequency of any periodic force created by the engine or compressor. As was noted in the discussion of Fig. 6, if the supports are spaced so that the ratio of the frequency of the disturbing force to the natural frequency of the piping is greater than 1.4, magnification factors of less than one can be obtained. This will result in piping which will be almost free of vibration.

A disadvantage of designing for ratios in this range is that when an engine is shut down, at some instant before it comes to rest the frequency of the forces which it emits will be in resonance with the piping. This might cause destructive vibration. While this difficulty can be overcome by installing vibration dampners on the piping, it is probably safer practice to design for ratios of between 0.25 and 0.50, even though this results in magnification factors slightly greater than one.

Particular attention must be given to supporting piping at points where changes in direction occur. At these points, the piping is subject to both the forces emanating from the engine and those set up by the pulsating flow of gas from the compressor cylinders. In case the change in direction is installed for the purpose of securing flexibility, it may be necessary to use springs or other types of elastic supports.

It might be possible to eliminate vibration in expansion bends if they were designed to be symmetrical about an axis coincident with that of the main pipe line. In this case components of pressure in all directions except the original direction of flow would neutralize each other.

Lengths of piping between the compressor cylinder and the surge chamber or header, and between surge chamber and header, or between headers, should not be equal to the resonant length for the frequency at which gas pulsates in the line. If resonant lengths cannot be avoided, the magnitude of the standing pressure wave formed can be limited by installing a condenser or surge chamber in the line near the compressor cylinder. The required volumetric capacity of the condenser is a function of the piston displacement of the cylinder, the normal pressure in the line, and the permissible pressure rise.[15]

Now, even the best of engineers sometimes make mistakes; either errors of omission or the other kind. So it is always well to have a few aces up the sleeve just in case there is a joker somewhere in the design. The standard method of dealing with a vibrating pipe is to install more supports and more and heavier pipe clamps. This is equivalent to increasing the natural frequency of vibration of the piping. The natural frequency of vibration of a section of piping can also be increased by attaching a spring to it. The spring is selected and loaded so that the natural frequency of the spring, load, and piping is sufficiently greater than the disturbing frequency to reduce the magnification factor by the required amount.

Another approach as indicated by the Magnification Factor Chart, Fig. 6, is to reduce the number of supports. In this way magnification factors of less than one can be obtained. The hazards of this approach should be kept in mind when it is used.

The amplitude of the vibration can also be limited by the installation of damping devices such as hydraulic shock absorbers or friction type snubbers.

Another effective means of reducing vibration in piping is the use of dynamic vibration absorbers. These consist of a weight suspended on an elastic member from the vibrating piping. The natural frequency of the weight and elastic suspension should be the same as the natural frequency of the vibrating member. The relationship between the amplitude of the vibration of the original member in such a system and the ratio of the frequency of the disturbing force to the natural frequency of the compensating systems is shown in Fig. 11 for zero damping and for a damping coefficient of 0.10. Inspection of the figure shows that the device cannot be used if the range of disturbing frequencies is too great.

Some, no doubt, would have appreciated a mathematical presentation of the subject. This approach was purposely avoided because the mathematics is fully developed in books dealing with special phases of the subject. These books and some of the formulas to be found therein are listed in the appendix.

The principal aim of the article has been to give a Cook's tour prospectus of the three avenues of approach to the problem of designing compressor plants which will be free of troublesome piping vibration. It will have been accomplished if the reader has been encouraged to further explore these approaches.

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Appendix

The appendix for this article, a compilation of the fundamental mathematical formulas of vibration, will be found on pages R-146 and R-147, immediately following.

The subjects covered include (a) Fatigue Strength; (b) Free Harmonic Vibration, Forced Damped Vibration, Elastic Supports, Dynamic Vibration Absorber; (c) Propagation of Pressure Waves; (d) Pressure Due to Deviated Flow; (e) Resonant Length of Pipes, and (f) Weight of Foundation.

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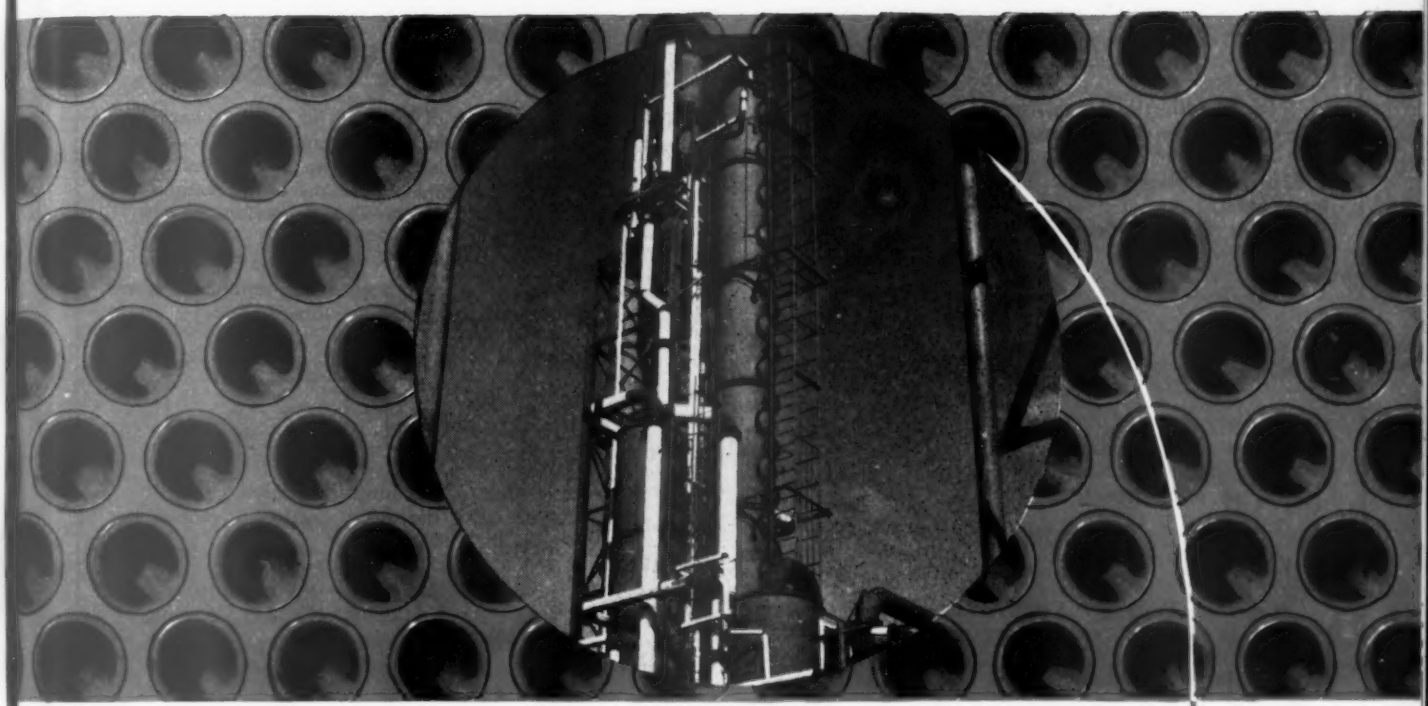

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MATHEMATICS OF VIBRATION

A. Fatigue Strength

(Reference—Johnson: *Materials of Construction*, Chap. 28).

A formula for determining the maximum permissible unit stress during a cycle is as follows:

$$S_{max}=\frac{0.5S_u}{1-0.5r}$$

where:

S_u = ultimate tensile strength of the material, and
r = ratio of minimum to maximum stress during the cycle.

S_u can be replaced by S_w. ($S_w = S_u$ divided by the Factor of Safety).

Another formula, developed on a different basis is as follows:

$$S_{max}=\frac{2S_1}{\left(1-r\right)+\frac{S_1}{S_y}\left(1+r\right)}$$

where:

S_1 = the endurance limit for completely reversed stresses, and
S_y = yield strength.

B. Vibration

(Reference—Freberg & Kemler: *Elements of Mechanical Vibration*).

1. Free Harmonic Vibration.

The natural frequency of vibration (f_n) of a mass suspended from a spring of negligible mass is

$$f_n=\frac{1}{2\pi}\sqrt{\frac{Kg}{W}}$$

where:

K = spring constant (psi),
g = acceleration (in)./(sec.)^2 due to gravity,
W = weight (lbs.),
π = 3.1416, and
f_n = natural frequency of vibration, cycles per second.

The spring constant (K) for two springs in parallel and having constant K_1 and K_2, respectively is

$$K=K_1+K_2$$

If the same springs operate in series, the constant (K) for the system is

$$K=\frac{K_1K_2}{K_1+K_2}$$

The spring constant is further defined as

$$K=F/d=W/d$$

where:

F = force in pounds acting on spring, and
d = deflection of spring in inches.

Expressed another way

$$d=W/K \quad \text{or} \quad K/W=1/d$$

Therefore, substituting in our earlier equation,

$$f_n=\frac{1}{2\pi}\sqrt{\frac{g}{d}}$$

The natural frequency of vibration of a beam, such as a pipe between supports, can be approximated by computing the maximum deflection due to its own weight and substituting in the above formula. For an exact method see Timoshenko: *Vibration Problems in Engineering.*

2. Forced Damped Vibration.

If a periodic force acts upon a system susceptible to vibration, the amplitude of the resulting vibration is

$$X=\frac{F}{K}\left[\frac{1}{\left(\left[1-\left(\frac{V}{W_n}\right)^2\right]^2+\left[2C\frac{V}{W_n}\right]^2\right)^{1/2}}\right]$$

where

X = amplitude of the forced vibration,
V = frequency of the disturbing force (radians per second),
W_n = $2\pi f_n$ radians per second, and
C = coefficient of damping = ratio of actual damping to critical damping. [Critical Damping = $2(W/g)W_n$].

The term

$$\frac{1}{\left(\left[1-\left(\frac{V}{W_n}\right)^2\right]^2+\left[2C\frac{V}{W_n}\right]^2\right)^{1/2}}$$

is called the magnification factor and is shown in Fig. 6.

3. Elastic Supports.

If a vibrating machine is supported on a substructure by an elastic medium, the ratio of the force transmitted to the substructure to the disturbing force is

$$T.R.=\left[\frac{1+(2CV/W_n)^2}{\left[1-\left(\frac{V}{W_n}\right)^2\right]^2+\left[2C\frac{V}{W_n}\right]^2}\right]^{1/2}$$

$T.R.$ = transmissibility = ratio of force transmitted to substructure to disturbing force. This relationship is shown graphically in Fig. 9.

4. Dynamic Vibration Absorber.

If a body is vibrating it is possible to reduce or eliminate the vibration by suspending from the vibrating body a weight supported by an elastic member. If W_1 and K_1 represent the weight and spring constant of the system in which the vibration is occurring and W_2 and K_2 represent the weight and spring constant of the system suspended from it to control the vibration then the amplitude of the movement of W_1 is as follows:

MATHEMATICS OF VIBRATION (Continued)

$$X_1=\frac{F}{K_1}\times\left(\frac{1-(V/W_{n2})^2}{\left[1-\left(\frac{V}{W_{n2}}\right)^2\right]\left[1+\frac{K_2}{K_1}-\left(\frac{V}{W_{n1}}\right)^2\right]-\frac{K_2}{K_1}}\right)$$

where

$$W_{n1}=\left(\frac{K_1 g}{W_1}\right)^{1/2}$$

$$W_{n2}=\left(\frac{K_2 g}{W_2}\right)^{1/2}$$

This function is shown graphically in Fig. 8. When $V = W_{n2}$, the amplitude of the motion of W_1 may be reduced to zero by making $K_2/W_2 = K_1/W_1$, or since $K/W = 1/d$, this may also be expressed as $1/d_2 = 1/d_1$.

The amplitude of motion of W_2 is

$$X_2=\frac{F}{K_1}\times\left(\frac{1}{\left[1-\left(\frac{V}{W_{n2}}\right)^2\right]\left[1+\frac{K_2}{K_1}-\left(\frac{V}{W_{n1}}\right)^2\right]-\frac{K_2}{K_1}}\right)$$

C. Propagation of Pressure Waves

(Reference—Thornton: *Mechanics Applied to Vibration and Balancing*, Chapter 4.)

The rate of propagation of pressure waves thru an elastic medium is

$$a=\left(\frac{E_g}{d}\right)^{.5}$$

where

a = rate of propagation of disturbance (ft.)/sec.,
E = modulus of elasticity of medium (lbs.)/(ft.)^2,
g = acceleration of gravity (ft.)/(sec.)^2, and
d = density (lbs.)/(ft.)^3.

This is sensibly the velocity at which sound is propagated in the material.

At the interface between two materials having dissimilar values of a, a portion of the stress due to pressure waves will be reflected back. If P_A is the stress due to the original wave, then the reflected stress will be

$$P_B=\left[\frac{(E_2d_2)^{.5}-(E_1d_1)^{.5}}{(E_2d_2)^{.5}+(E_1d_1)^{.5}}\right]P_A$$

and the transmitted stress is

$$P_C=\frac{2P_A}{1+\left(\frac{E_1d_1}{E_2d_2}\right)^{.5}}$$

Subscript 1 refers to the medium from which the stress is being transmitted. Subscript 2 refers to the medium to which the stress is being transmitted. A negative value indicates that the reflected or transmitted stress produces a state of tension.

D. Pressure Due to Deviated Flow

(Reference—Marks: *Mechanical Engineers Handbook*, 4th Edition, Page 279.)

If the direction of flow of a stream is changed, the pressure or thrust in the direction before turning is

$$P=(Qw\,V/g)(1-\cos B)$$

Where

Q = quantity flowing per second,
w = weight of unit volume of fluid,
V = velocity of fluid,
g = gravity acceleration constant, and
B = angle thru which flow is deviated, measured from direction before turning.

The total resultant pressure is

$$P=(Qw\,V/g)[2(1-\cos B)]^{.5}$$

The direction of the resultant force is 90° from midway between the original and final direction of the flowing liquid.

E. Resonant Length of Pipes

(Reference—Olson: *Elements of Accoustical Engineering*, Page 47.)

The fundamental resonant frequency of a pipe open at both ends is

$$f=a/2L$$

If the pipe is closed at one end

$$f=a/4L$$

where

f = resonant frequency in cycles per sec.,
a = velocity of sound in gas in ft. per sec., and
L = length of pipe in feet.

In the case of a pipe closed at one end, such as between a compressor cylinder and surge chamber or header, lengths corresponding to the fundamental frequency should be avoided, and if possible the second harmonic.

In the case of a pipe open at both ends, such as between a surge chamber and a header, or between two headers, lengths corresponding to the fundamental and, if possible, the third harmonic, should be avoided.

F. Weight of Foundation

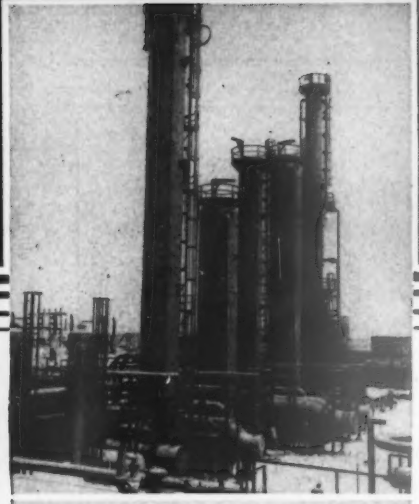
(Reference—Slocum: *Noise and Vibration Engineering*, Page 44.)

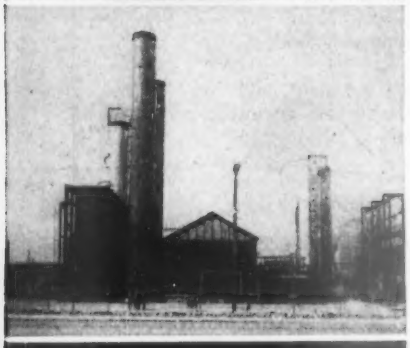
The weight of a foundation which will result in a given amplitude of the lateral motion b of a foundation and reciprocating machine of horizontal type is given as follows:

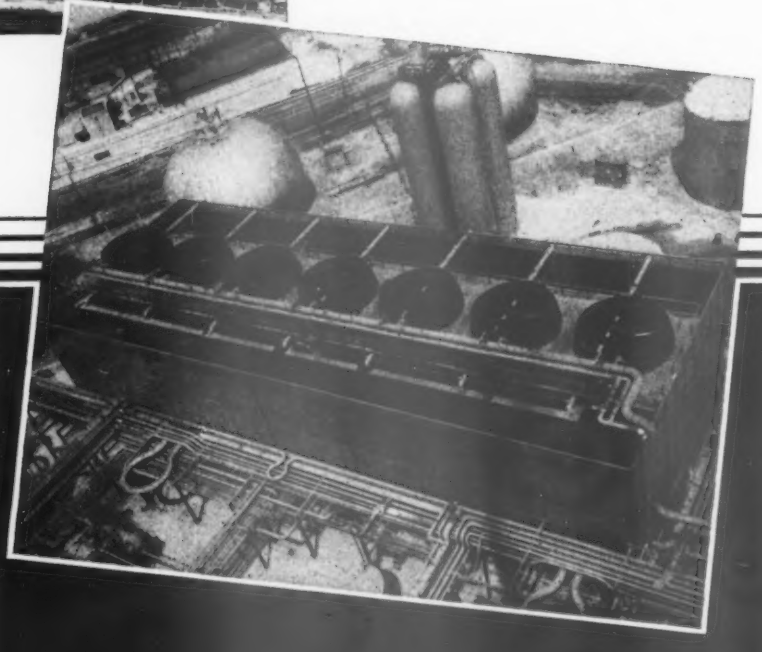
$$W_4=\frac{r}{b(1+K)}\left[W_1+W_2\left(1-\frac{1}{q}\right)\right]-\frac{W_3}{1+K}$$

where

W_4 = weight of foundation,
W_2 = total dead weight of engine in lbs.,
W_3 = weight of reciprocating parts in lbs.,
W_1 = weight of eccentric rotating parts in lbs.
r = crank radius in inches,
b = amplitude of vibrating motion in inches,
q = ratio of length of connecting rod to length of crank, and
k = ratio of mass of soil accelerated to mass of foundation.







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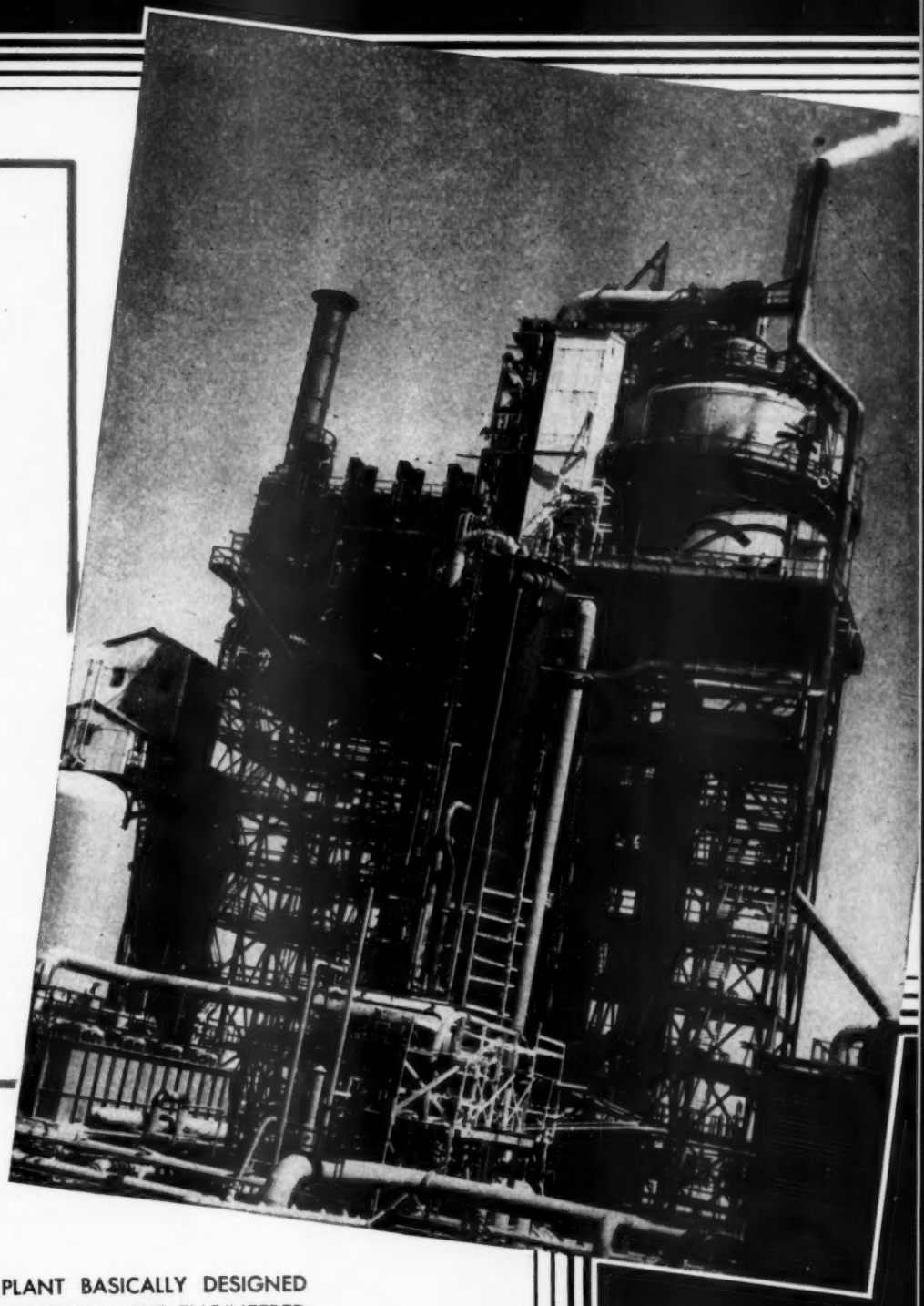

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Torque-Viscosity Characteristics Of Lubricating Greases*

*By L. C. Brunstrum, E. W. Adams and E. E. Ziegler***

ALTHOUGH many varieties of torque tests have been used to evaluate lubricants, the subject warrants our especial attention at this time because of the present widespread interest in the properties and behavior of greases in relatively slow moving bearings at temperatures as low as minus 100°F. The conventional function of torque determination at low temperatures is either the empirical evaluation of lubricants under a given set of mechanical and atmospheric conditions, or the determination of the most drastic conditions under which a given lubricant will give satisfactory service. However, if improvement of the lubricants is to continue, we must relate our tests to the more fundamental properties of the products.

Two torque methods are commonly used, (1) the constant torque-variable shear method in which a given load is applied and the resulting speed measured and (2) the constant speed-variable torque technique in which the bearing is driven at constant speed and the resulting force is measured on the other bearing race. From a mechanical point of view the results by these methods should be identical. However, because of the peculiarities of lubricating grease consistency (apparent viscosity), the results are not comparable unless certain precautions are taken.

We will attempt to compare the type of results obtained by the two methods and to express the data in terms of viscosity. Shear rate, a variable which must be controlled in grease viscosity measurements, will be shown to require close control in torque measurements also.

Description of Equipment

The best constant torque device is that currently being recommended by the joint ABEC-NLGI Committee on low temperature torque tests(1). Considerable cooperative work has eliminated most of the technique variables such as bearing packing method, extent and frequency of disturbing the sample while cooling and numerous small design features. Two major disadvantages of constant torque methods have been overcome to some extent by restricting the rate of rotation to 1 to 3 rpm., thus automatically narrowing the range of shear rate to an approximate variation of 1 to 3, and by reporting the data as "plasticity number" (torque × time).

To obtain a direct comparison of results by the two methods a tester was built which is capable of being operated at either constant torque or at constant shear rate. Conversion is accomplished by simply changing the drive, i.e., by using weights or a motor. Three bearings mounted on a horizontal shaft are used to minimize slight variations in bearing fits and grease packing.

Fig. 1 is a general view of the tester as operated at constant torque. A collar fits over the outer races, tying them together so that they rotate freely as a single unit. By adding weights to a cord which runs over a pulley integral with this collar any desired torque may be applied in either direction to the bearing assembly. This loading arrangement eliminates the unknown and variable friction encountered when an outboard bearing is used to support the end of a shaft on which the test bearings are mounted. One, two or three eight-ball, No. 204 ball bearings can be installed with or without shields.

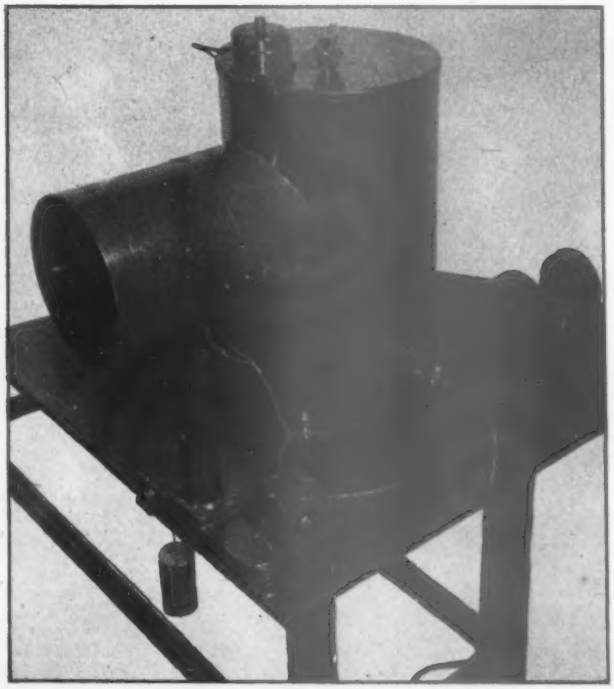
An insulated cover which encloses the test bearing chamber is removable, allowing easy access to the bearings, and providing for visual inspection of the bearings in operation when desired. An adjustable stop located in this removable cover allows smooth application of the desired torque and automatic stopping after 15 in. of movement or at the end of any complete revolution.

Thermocouples (Fig. 2) are located (1) in the center of the test bearing shaft, (2) in the enclosed air space ⅛ in. from the outer race retainer, and (3) in the cooling chamber itself. For refrigeration, the latent heat of vaporization of carbon dioxide is utilized. A suitable coolant, such as oleum spirits, is circulated by a small rotary pump through an annular jacket around the test bearings and also, by means of suitable tubing, through a chamber containing liquid carbon dioxide.

The pressure in this chamber is regulated and the boiling point of the liquid CO_2 thereby adjusted until the bearing assembly reaches the desired temperature. A weight-loaded "pop-off" or pressure-relief valve is provided for this purpose. So that the valve will not freeze and become inoperable, it is located at the lowest point in the chamber in order that it will

*Presented before the 12th Annual Meeting of the National Lubricating Grease Institute, Chicago, Oct. 23 to 25, 1944.

**Research laboratories of Standard Oil Co. (Indiana), Whiting, Ind.



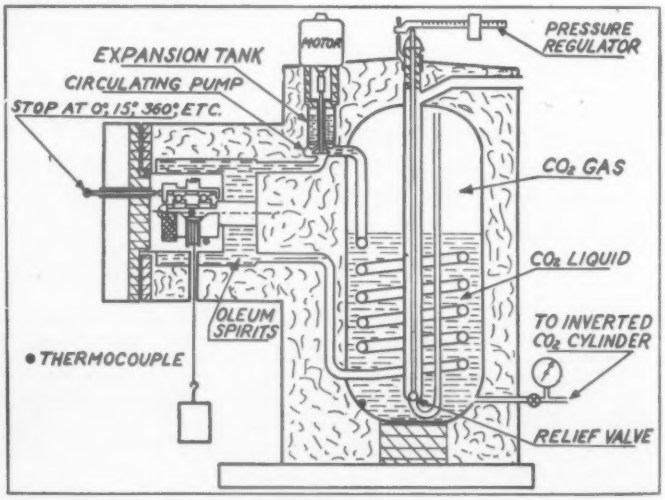
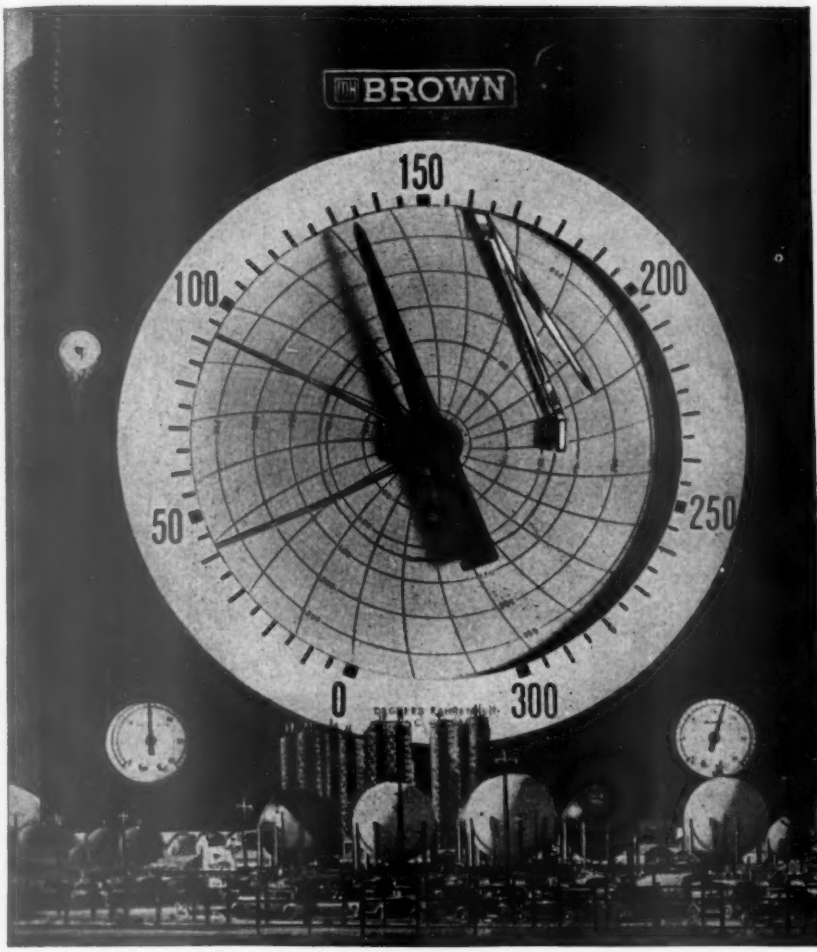


Fig. 1 (left)—General view of tester operated at constant torque to evaluate lubricants

Fig. 2 (above)—Cross sectional view of the tester, showing cooling mechanism and location of thermocouples



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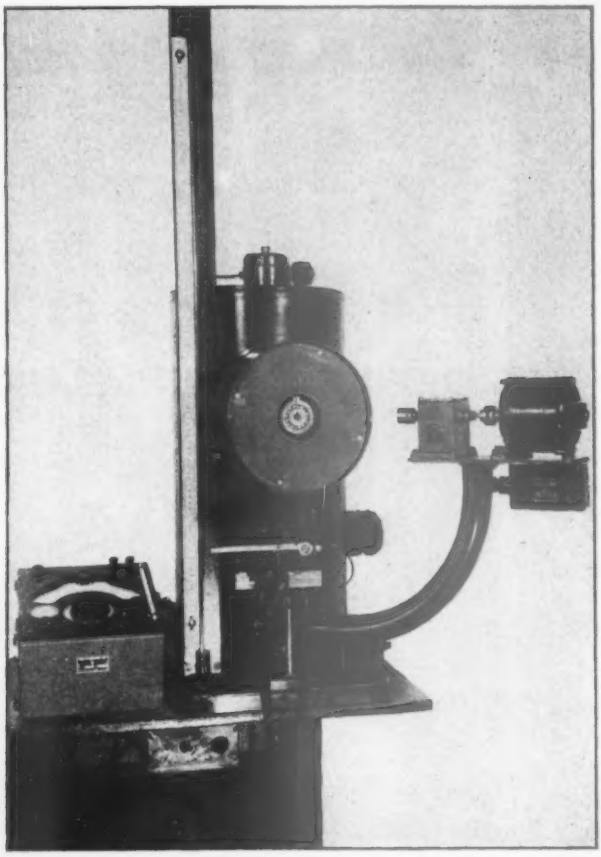

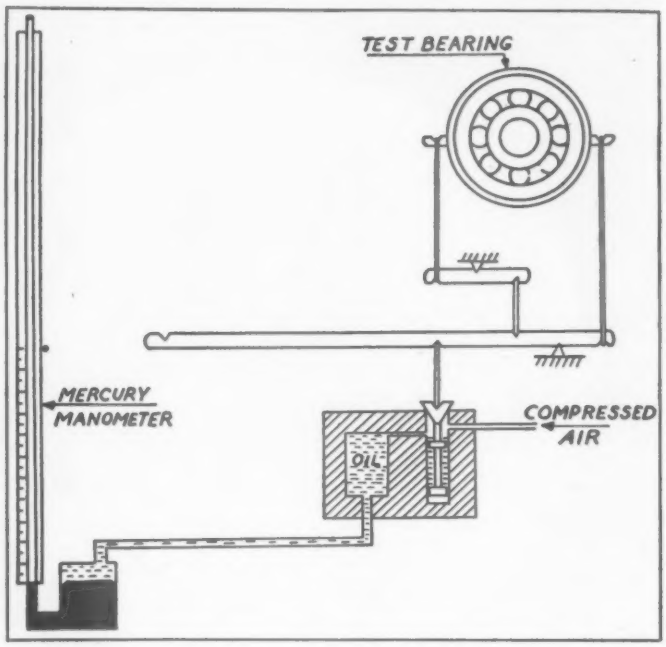

Fig. 3 (left)—Tester set up to be operated at constant shear, with driving power furnished by a 1/20th HP synchronous motor mounted on a swivel arm

Fig. 4 (above)—Schematic drawing of torque measuring device

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be covered by liquid as long as any is present.

Once the required pressure is reached and the weight loading of the valve fixed, the liquid CO_2 keeps boiling at a constant temperature. Any small increase in temperature produces an increase in pressure sufficient to open the pressure-relief valve. The original conditions of temperature and pressure are promptly restored by the cooling effect exerted as more liquid boils off and gaseous CO_2 expands through the valve opening. Equilibrium conditions result from repeated opening and closing of the relief valve in this manner until finally a very small quantity of gas passes out at a steady rate. Inasmuch as a pressure change of 3 psi. corresponds roughly to a 1°F. change in the boiling point of liquid CO_2, the device affords quite precise temperature control. It requires a minimum of attention and operates almost noiselessly without odor or objectionable waste products.

When the tester is operated at constant shear rate the drive consists of a one-twentieth horsepower synchronous motor turning 1800 rpm. and a 900:1 gear reducer, both mounted on a swivel arm. This arrangement provides inner bearing race rotation of 2 rpm. in either direction, which speed was selected because it corresponded with the 30-second interval specified by the AXS- and AN-G-3 tests for one revolution. Fig. 3 shows this power drive rotated out of working position.

Torque is read directly from a mercury manometer which is actuated by compressed air regulated by a needle valve attached to the torque string. The method of operation is shown schematically in Fig. 4. This part of the device has been found very responsive. Its range may be changed by adjusting the lever arm attached to the torque string.

Torque-Time Relationships

As grease manufacturers we are interested in interpreting our results in terms of the fundamental properties of our products. Torque data have little meaning to a manufacturer of grease unless he can interpret them in terms of oil viscosity, soap content, etc. For example, to improve "channeling properties" of a grease we do not remove X "channel units," but rather we reduce the low shear rate viscosity by decreasing the soap content and/or by lowering the oil viscosity. So with torque tests we must relate the data to apparent viscosity and finally to soap content and oil viscosity.

When a Newtonian lubricant is used, it is reasonable to assume that a twofold increase in applied torque would produce a twofold increase in rpm of the test bearing. In other words the product of torque and time for one revolution would be a constant. This is of the same nature as the coefficient of viscosity and in fact

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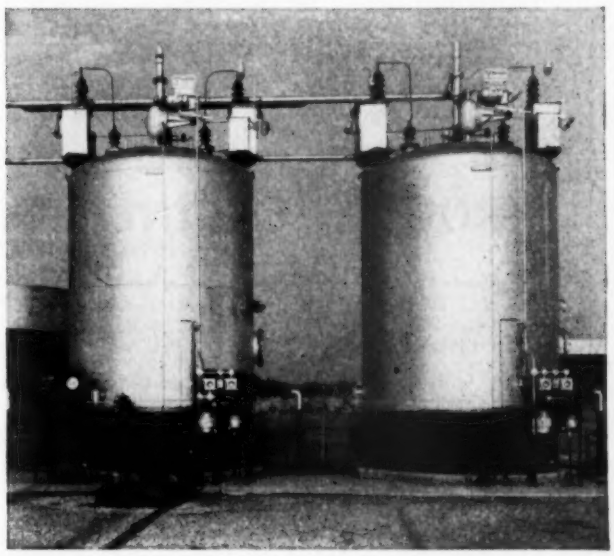
Refiners should bear in mind that operational benefits like these not only increase potential on stream time and through-put capacity, but in reducing mechanical failures and shutdowns, they also conserve manpower and materials. These are factors that must not be overlooked.



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would be the coefficient of viscosity of a Newtonian liquid if expressed cgs units. The dimensions of torque × time are

$$\underset{\text{(Torque)}}{(ML^2)/T^2} \times \underset{\text{(time)}}{T}$$

or $(ML^2)/T$, which may be written

$$\underset{\text{(viscosity)}}{M/(LT)} \times L^3$$

in which L^3 represents constant bearing dimensions. By analogy, when a non-Newtonian product is tested, the product of torque and time per revolution is proportional to apparent viscosity. This is also true of the "plasticity number" (torque × time) in the ABEC-NLGI method.

In constant torque tests selected from determinations at 1 to 3 rpm., the average shear rate varies three fold and the actual rate (not considering the variation from point to point within the bearing) varies from zero to at least that equivalent to 6 rpm. We are discussing the range of shear rate and temperatures in which the products likely to be tested have almost a twofold change in apparent viscosity for a twofold change in shear rate.

It is obvious that the shear rate must be exactly controlled to get reproducible results from laboratory to laboratory. To be sure, this will not smooth out variations due to other causes, such as, for example, a rough bearing. Check results can never be obtained if the shear rate varies. In fact, identical results at other than identical shear rates are in error and dissimilar results at different shear rates may actually be checks.

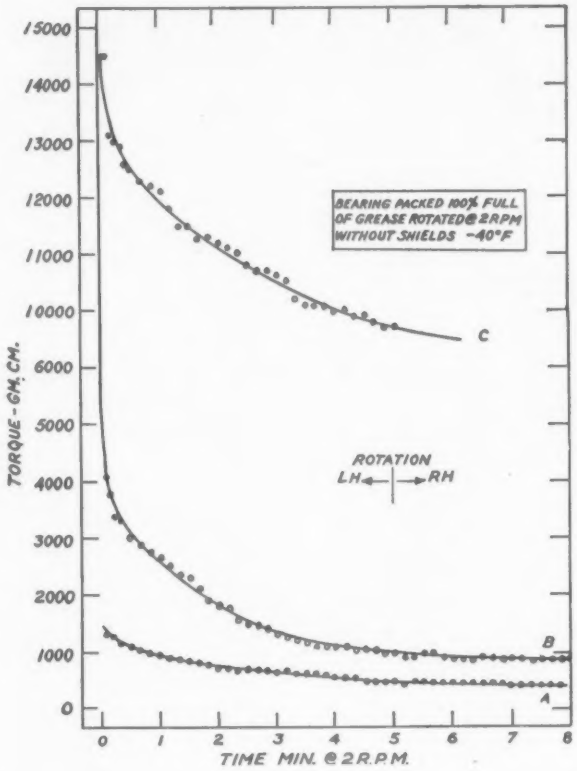

Fig. 5—Torque-time curves for three samples of grease, with the tester operating at constant shear

Fig. 5 represents torque-time curves on samples A, B and C, with the tester operating at constant shear. The highest manometer reading occurs just as the motor is started. This break-away torque is shown at zero time. Thereafter the manometer is read every 10 seconds as the torque drops from the break-away to the equilibrium or running torque. In the case of samples A and B the motor was stopped after 5 minutes operation and started in the opposite direction (after 15-minute cooling period). No change in torque values is found after the bearing rotation is reversed.

The rapid decrease in torque during the first several revolutions is caused by excess grease being forced from the path of the balls and "working down" any structure the grease developed during the cooling period. Constant torque methods fail to provide this information because it is not possible to ascertain the instantaneous rates of rotation equivalent to the torque variations of the constant speed methods. Working the grease during the cooling period results in only the equilibrium values.

This curve can also be used to explain why the elaborate precautions specified in the present ABEC-NLGI constant torque method are necessary. Limiting the amount of grease used, running the bearing in before use, and intermittent operation while cooling all tend to make the break-away torque and equilibrium

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torque closer together, and nearer to reflecting grease viscosity.

Use of constant shear also has the advantage of the possibility of relating the results to apparent viscosity. When this is done the preliminary work carried out on difficult-to-control simulated service devices may be transferred to the more scientic laboratory pressure viscometer.

The shear rate in a complicated device can be estimated by testing both a grease and its oil in the device and in the pressure viscometer. There is only one shear rate for a given ratio of oil viscosity to grease viscosity for any given grease. The ratio obtained on the test device may be compared with the variable ratios obtained on the viscometer. The shear rate at which the ratios on the device and viscometer are equal may be taken as the effective shear rate in the device.

Torque vs. Temperature

One of the more important considerations is the effect of temperature on torque values of greases. In Fig. 6 is shown a family of torque-time curves. It will be seen that small temperature changes produce quite large changes in torque. The equilibrium torque values may be plotted against temperature or may be converted to viscosity and plotted against temperature.

It has been shown that "plasticity number" or torque × time is related to viscosity. The equilibrium torque in constant speed devices is an excellent measure of viscosity and may be expressed as "plasticity number" or torque × seconds for 1 revolution simply by dividing torque by revolutions per second. However, torque × time values on a series of greases represent viscosities in some unknown units comparable only with other similar tests. By means of an arbitrary constant, it has been possible to convert these values to Saybolt viscosity, this scale having been chosen only because of its widespread use.

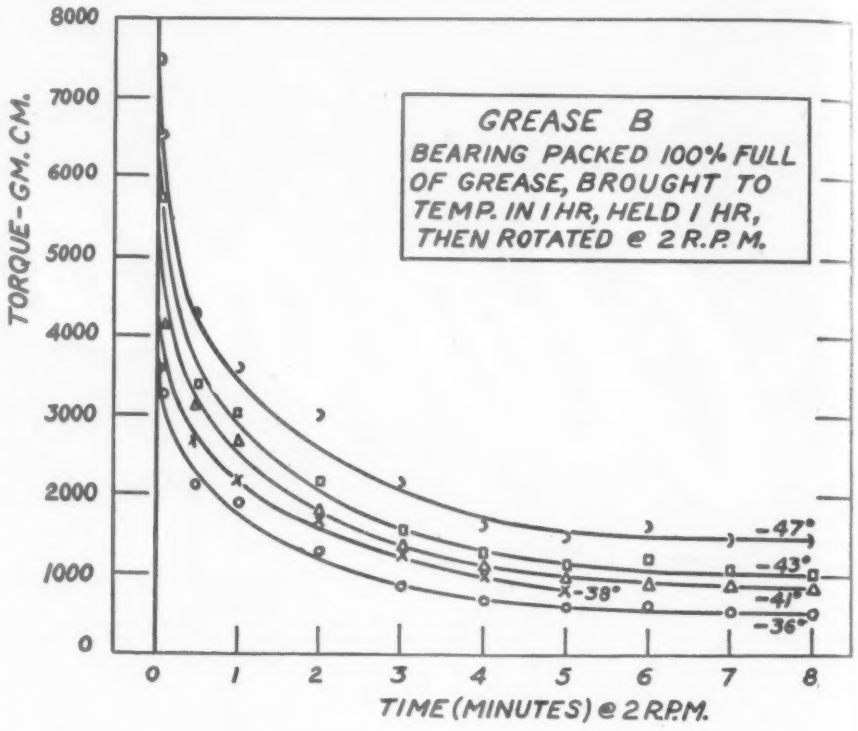
GREASE B
BEARING PACKED 100% FULL OF GREASE, BROUGHT TO TEMP. IN 1 HR, HELD 1 HR, THEN ROTATED @ 2 R.P.M.
TORQUE - GM. CM.
TIME (MINUTES) @ 2 R.P.M.
-47°
-43°
-41°
-38°
-36°

Fig. 6—Torque-time curves for five samples of a grease tested at varying operating temperatures

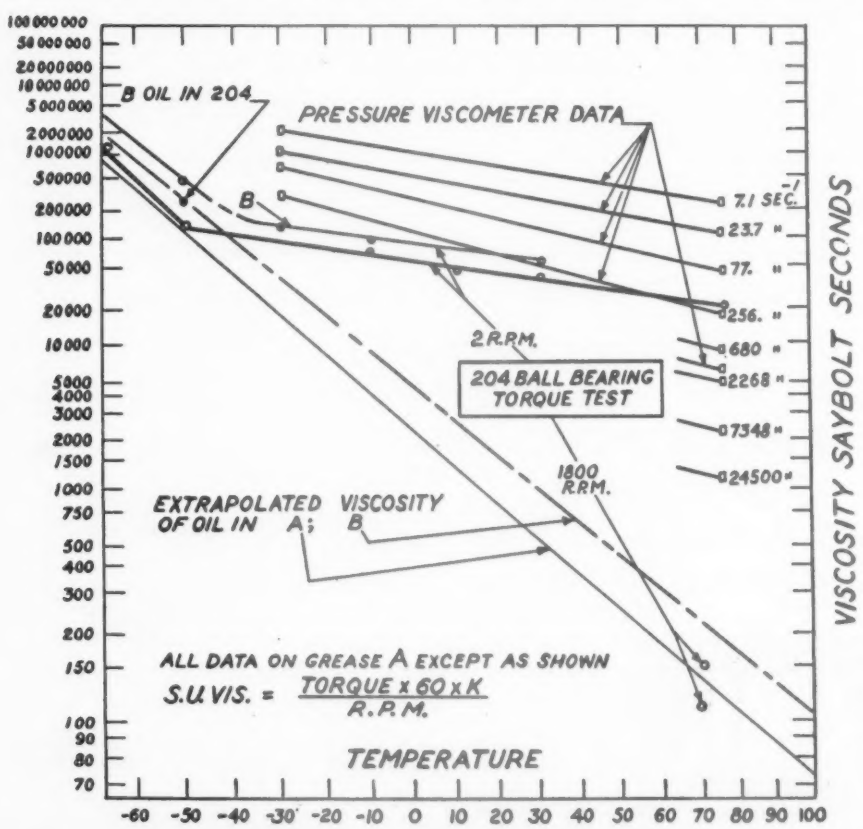

Fig. 7—Low temperature torque tests, with all data converted to Saybolt viscosity by means of an arbitrary constant

In Fig. 7 all of the data have been converted to Saybolt viscosity, although none was obtained as such. The long lines are the extrapolated viscosity of the oil in sample A and sample B. These were converted from suspended level observations. The series of lines labeled "pressure viscometer data" were obtained as absolute viscosity and converted to Saybolt viscosity. Finally the lines marked "204 ball bearing torque test" were obtained as torque × time data and converted to Saybolt units by means of the arbitrary constant. Obviously this numerical value is applicable only to 204 bearings operated at 2 rpm. but could be used in general according to the formula shown in the figure. Evaluation of the constant was carried out as follows:

The oil used in grease B was frozen in the bearing at about —100°F., placed in the machine and warmed to the test temperature. The bearing was then tested at —50°F. and 2 rpm. By multiplying the equilibrium torque by 30, the time for one revolution at 2 rpm, a value is obtained which is equivalent to the regular "plasticity number." When this value is multiplied by ten, it falls approximately on the extrapolated oil viscosity. Accordingly this factor is a satisfactory empirical

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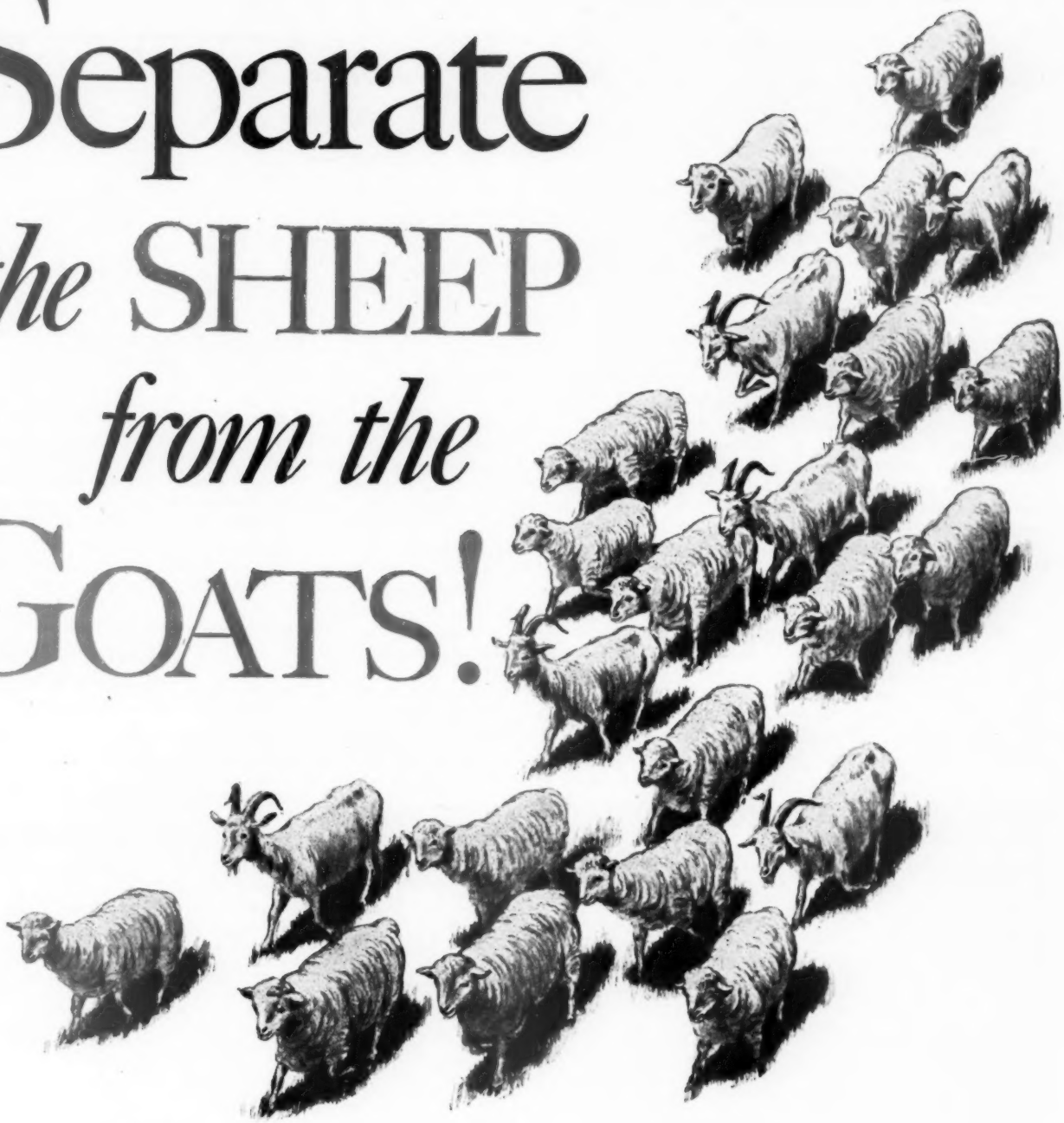

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conversion from "plasticity number" to Saybolt viscosity.

This value was also obtained by another method. It is now generally known that the grease viscosity approaches the oil viscosity at high shear rates (also at low temperatures, the latter making the oil viscosity extremely high). The former situation was simulated by running grease A at a higher temperature, at which the oil viscosity was relatively low, and at very high shear rate. In this case the bearing was operated at 1800 rpm. A value which agrees quite well with the oil viscosity is obtained after the "plasticity number" so determined is multiplied by ten. The two values shown in Fig. 7 represent tests with and without side shields. It should be pointed out that this method of evaluating the constant is quite accurate because of the extended scale used on the lower portion of the ASTM chart. The actual torque × time values of 11 and 15 would be far off the bottom end of the scale if the factor of 10 had not been employed.

The equilibrium torque values used to calculate the viscosities shown in Fig. 7 are taken from charts typified by Fig. 5 at 5 minutes. Actually there is a very slight decrease in torque after five minutes which is believed to represent a slow increase in temperature of the bearing. When the "plasticity number" so obtained (torque × 30) is multiplied by 10 it will be seen that the grease viscosity has a straight line temperature relationship until it reaches approximately to the viscosity of the oil contained in the grease.

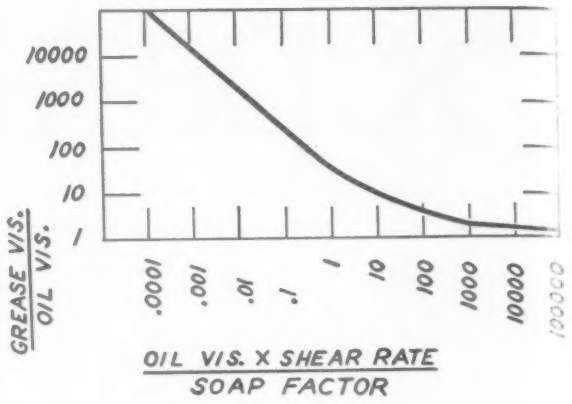

Fig. 8 — Viscosity-shear relationships

It should be noted, parenthetically, that at temperatures *above* this point lubricating greases behave as plastics, whereas at temperatures *below* this point they behave as viscous oils. We have chosen, therefore, to refer to this point at which the transition in properties of a lubricating grease from those of a plastic body to those of a viscous oil occurs, as the Plasticity Point. With grease A, as shown in Fig. 7, our experimental value appeared to fall exactly at the Plasticity Point. The curve obtained with grease B is, we believe, somewhat more typical, since it is improbable there is an abrupt point at which the transition occurs, but rather a more gradual although positive conversion. We have chosen, therefore, to define the Transition or Plasticity Point as the point of intersection of the grease like and oil like sections of the curve.

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TECHNICAL MEETINGS FOR OIL MEN

In response to recent government requests, many technical societies have cancelled or postponed their usual annual and semi-annual meetings. To the extent that we have the information available, the listings below give the meetings which had already been scheduled and their present status.

FEBRUARY

8-9, Amer. Society of Lubrication Engineers, 1st National Convention, Hotel Stevens, Chicago. **(Cancelled)**

19-22, Amer. Institute of Mining & Metallurgical Engineers, Annual Meeting, Hotel Pennsylvania, New York. **(Cancelled)**

28, Amer. Society for Testing Materials, Spring Meeting, Hotel William Penn, Pittsburgh.

MARCH

12-14, National Association of Corrosion Engineers, President Hotel, Kansas City, Mo.

APRIL

1-3, Amer. Institute of Chemical Engineers, Houston. (Request for permission to hold this meeting now pending)

4-6, Amer. Gas Association, Technical Section - Conferences, Hotel Stevens, Chicago. **(Cancelled)**

MAY

16-17, Society of Automotive Engineers, Diesel Fuel and Lubricants Meeting, Hotel Carter, Cleveland. (Request for permission to hold this and other SAE meetings now pending)

21-23, Amer. Gear Manufacturers Association, The Homestead, Hot Springs, Va. **(Cancelled)**

JUNE

18-22, Amer. Society for Testing Materials, 48th Annual Meeting, Hotel Statler, Buffalo, N. Y.

In addition to the above, the following groups have cancelled or postponed meetings which had been tentatively scheduled:

American Association for the Advancement of Science.

American Chemical Society, Annual Spring Meeting.

Natural Gasoline Association of America.

Western Petroleum Refiners Association.

further changes in the viscosity of the grease are controlled by changes in the viscosity of the oil. The shape of this whole curve at the high viscosities in question would be roughly the same had the values not been multiplied by ten, but the grease viscosity would have been below the extrapolated oil viscosity. This is additional reason for believing that the factor of ten is approximately correct.

It is of interest to compare the shape of this viscosity-temperature curve with published data on apparent viscosity of greases. Arveson[2] has shown that the apparent viscosity of a whole series of greases at varying temperatures can be represented by a single line by plotting the ratio of grease viscosity to oil viscosity η_g/η_o against the ratio of oil viscosity × shear rate to soap factor. This curve (Fig. 8) shows that at either high shear rate or high viscosity (heavy oil or low temperature) the grease viscosity approaches the oil viscosity. Cooling a grease and testing its viscosity at constant shear rate is equivalent to moving along the curve from left to right (soap factor changes only slightly with temperature). By arbitrarily selecting, for example, an oil viscosity of 1,000,000, a soap factor of 100 and a shear rate of 10, we would be at the right side of the chart. In other words, the grease viscosity and oil viscosity would be nearly equal.

Further cooling of the grease will result in viscosity changes which are controlled by and are equal to the change in oil viscosity. If this were not true, the grease viscosity would be less than the oil viscosity if the grease viscosity-temperature curve is extended indefinitely to the left in Fig. 7.

Since "plasticity numbers" are really apparent viscosity, the above considerations show why the values on torque devices approach the extrapolated oil viscosity lines. This same technique has been applied to dispensing data and for this report it is sufficient to say that curves similar to the "plasticity number"—temperature curve of Fig. 7 are obtained.

The reader is again requested to examine Fig. 7 while the following summary is being made:

1. The torque value of any grease at a given temperature (above its plasticity point) is any value from some high figure (depending on soap content) to almost the viscosity of its oil and depends on the shear rate of the test.

2. Torque values obtained in a 204 bearing at 2 rpm and converted to viscosity have about the same temperature-viscosity slope as pressure viscosity lines and appear to be equivalent to the shear rate range of 200 to 700 reciprocal seconds.

3. Grease viscosity has a smaller temperature coefficient than that of the oil in the grease even when both are considered in the same viscosity range. This is obviously not true in the extremely low temperature range where grease viscosity and oil viscosity are parallel.

4. The torque-temperature curve appears to be a straight line until the oil viscosity begins to predominate, at which temperature it bends off and is parallel to the oil viscosity line.

We believe that the future technology of grease testing rests on the theory that torque in a given bearing is for the most part, proportional to grease viscosity at the shear rate in use. We realize, on the other hand, that there are conditions such as channeling or grease flowing in a different manner as the grease cools which make the shear rate vary or even introduce other variables which may cause the apparent viscosity to deviate from that obtained by means of capillary flow. In our opinion, however, these factors should not be considered as making the torque-viscosity or dispensing-viscosity correlation untenable or the capillary viscosity unreliable, but rather that the deviation from capillary viscosity should be used *to explain* the action of the grease in the bearing.

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(1) Tentative Method for Determination of Low Temperature Torque Characteristics of Grease in Anti-Friction Bearings. ABEC-NLGI Committee.

(2) M. H. Arveson, Ind. Eng. Chem., 24, 71 (1932); 26, 638 (1934).

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Alcohol Tested as Injection Fluid for Gasoline Engines

A NEW development in the use of alcohol as fuel in gasoline engines was reported at the recent annual War Engineering meeting of the Society of Automotive Engineers, in Detroit, in a paper on alcohol-water injection as a means for suppressing detonation. (See pg. R-88 of this issue.)

The test work reported, performed by engineers of Thompson Products, Inc., of Cleveland, came about through wartime experience of some engine manufacturers with water injection as an internal coolant in aircraft engines. Injection under full engine load conditions resulted in increased power in takeoffs and during flight, particularly in supercharged engines. The tests of the Cleveland automotive concern on conventional truck and passenger car engines indicated, it was reported, that alcohol-water mixtures are superior to water alone in many cases.

In the series of tests in engines in ground vehicles, varying proportions of the alcohol-water mixture were injected, up to 25% of the total fuel charge, and also varying amounts of alcohol in the mixture. Fifty-fifty alcohol-water injection appears to be the most economical fluid for best results, the paper states. It was reported that the beneficial effects of alcohol-water injection are due both to cooling and to chemical action, and that best gains were realized when a fuel was used which was approximately 12 octane numbers lower than the engine requirement. This last factor, it would seem to indicate, provides a possibility for vehicle operating economies as well as improved engine performance.

The paper made it plain that the use of alcohol as an injection fluid was considered solely as a means to suppress detonation and did not cover alcohol as a primary motor fuel. The use of alcohol-water also was not expected to serve as a substitute for anti-knock quality in the fuel itself, it was brought out, but to supplement it and secure maximum performance in the engine. The report of the tests run brings out the number of engine performance factors studied to insure that the injection of the fluid was accurately controlled and emphasizes the importance, in any general application, of the exact control of the volume of the injection. An additional fuel system and means for controlling the amount of the mixture injected would have to be installed on the vehicle. The calibrating of the apparatus to insure for every make and condition of car that the fluid was injected in the proper amount would seem to present difficulties.

Despite these limitations, there is the possibility that the promoters of alcohol as motor fuel may look upon the report on this development work as endorsement by automotive engineers of the use of alcohol. In the past the promoters and enthusiasts for "alky-gas" have endeavored to bring it into use through legislation or other arbitrary means rather than because of economic or operating benefits.

The paper presented before the SAE at Detroit was limited in its scope to the *advantages* of alcohol-water injection. Further discussion, including the disadvantages, would seem to be in order. This principle of injection of a supplementary medium to the fuel is not new. Oil companies have studied it and their conclusions could well be stated now.

"Foolish" Research Has Paid Big Dividends

ANOTHER good reason why industrial research should continue to be free of centralized control, which the government still seeks to grab through legislation sponsored by Senator Kilgore, was related by Dr. Irving Langmuir in a talk during General Electric's radio program Jan. 21

When Dr. Langmuir first joined General Electric's research staff, it was suggested that he become familiar with all that was going on there, and then busy himself with projects of most interest to him. He decided to help find out why the carbon filaments in incandescent lamps failed so soon and what could be done about it.

In the course of his investigations, tungsten wire was substituted for the carbon filaments of Edison's day and, in an attempt to eliminate the embrittlement and blackening of the glass which followed use of these filaments in the highly-evacuated medium, substitution of inert gases was tried. The improvement was marked, despite fears of lamp experts that "gassy" bulbs would be unsatisfactory. Eventually heavier gauge filaments were successfully used to increase mechanical resistance to shock and, to the investigators' surprise, a marked increase in lamp efficiency also resulted.

Savings due to increased efficiency, purely a sideline in the main research, have resulted in savings of many millions of dollars to the consuming public, Dr. Langmuir stated. Had these research scientists not continued to "play" with an idea in the interests of pure science rather than for the primary purpose of increasing lamp efficiency, it is doubtful if increased incandescent lamp efficiency would have come so soon, if ever.

These investigations of Langmuir and associates could not have been justified before a research commission or centralized research authority, because even the investigators did not know where the trail they wanted to follow would lead. They simply were curious as to what would happen if they did certain things, and why those things happened. A centralized authority, not technically familiar with any specific field, in all likelihood would have turned thumbs down on such an obvious waste of time and money. Langmuir would have been put to work on something "important."

How much time, effort, money has been spent on what seemed like "blind alleys" in the petroleum field, but which later led to profitable results? What justification did that "foolish" man have who first thought of cracking?

As has been said so many times before, if it had not been for the unfettered research "tinkering" of so many oil scientists down through the years, this nation would not be fighting World War II in the manner it now is. Perhaps we would be heiling Hitler, Tojo and Mussolini instead.

All research, save that of government agencies for military purposes and in fields outside the province of individual industries, should continue to be unhampered by any centralized authority, no matter how august or technically well-informed.

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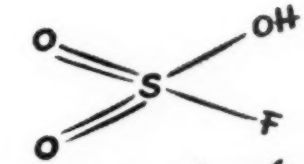

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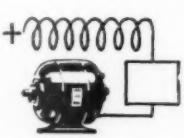
Freezes at –125° F. (–87.3 C.)
Specific Gravity: 1.743 at 60° F. (15.6° C.)
Vapor pressure: 3 mm Hg at 80° F. (26.7° C.)
Specific Electrical Resistance: 205 ohms per cubic cm at 86° F. (30° C.)
Viscosity: 1.7 centipoises at 68° F. (20° C.)
Heat of Formation from SO_3 (l) and HF (g): 25 kilocalories per mole.
Most salts soluble in water.

SOME FUTURE USES OF HSO_3F ($HO{\cdot}SO_2F$)

Alkylating agent in manufacture of high octane fuel for the post-war "plane-mobile."

Reagent in the production of synthetic polymers with dielectric properties.



In manufacture of dye intermediates.

In producing high pressure lubricants, cutting oils, etc.

In other research and manufacture involving organic or inorganic chemicals.

General Chemical Fluosulfonic Acid may open up a new avenue of approach to many of your research problems. For data on physical and chemical properties, etc. *write for Technical Service Bulletin No. 33-A today.* Address your request to the Technical Service Office nearest you.

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Acid Hydrofluoric, Aqueous
Aluminum Fluoride, Crystal
Ammonium Bifluoride
Ammonium Fluoride
Barium Fluoride
Boron Trifluoride
Chromium Fluoride
Cupric Fluoride
Fluoride Fluxes
Lead Fluoride
Lithium Fluoride
Magnesium Fluoride
Nickel Fluoride
Polyacid Fluorides (e.g. KF. x HF)
Potassium Fluoride, Anhydrous
Potassium Fluoride, Crystal
Sodium Bifluoride
Sodium Fluoride
Strontium Fluoride

Fluoborates

Acid Fluoboric
Ammonium Fluoborate
Cadmium Fluoborate
Chromium Fluoborate
Copper Fluoborate
Ferrous Fluoborate
Indium Fluoborate
Lead Fluoborate
Nickel Fluoborate
Potassium Fluoborate
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